THE PATHOLOGY AND SURGERY OF THE VEINS OF THE LOWER LIMB

TO

OUR WIVES

THE PATHOLOGY AND SURGERY OF THE VEINS OF THE LOWER LIMB

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FOREWORD

Diseases of the veins of the lower extremities and the pathological disorders secondary to them are the most common of human ailments that can be remedied by surgical measures Despite the prevalence of these conditions it is distressing and unfortunate in this day of modern surgery that the treatment of them is so unsatisfactory for the majority of the patients not a few of whom even are made worse by inadequate and inept therapy This is especially true since the majority of the disease complexes are curable if the proper operative treatment is performed as is so well demonstrated in this excellent book on the subject.

There are several reasons for these poor operative results in the hands of so many surgeons. In the first place it is in great part due to the failures of the profession to understand the basic pathological physiology of these venous disorders, which is so well described and documented in this book It is recommended that those interested in treating these conditions would be well repaid to study with care, especially the chapters dealing with this phase of the subject.

Another factor is that the patient suffering from these conditions is cared for and operated upon in many clinics by the youngest and least experienced members of the surgical team because the senior surgeons cannot be bothered with the tedious, time-consuming type of operative procedures necessary to obtain satisfactory results for these conditions. As a result of this state of affairs, the quality of treatment is generally below standard because the young surgeon has such a poor example set for him by his preceptors and teachers This state of affairs is especially well demonstrated by the results obtained in the treatment of chronic ulcers of the lower leg of venous origin which by and large has not improved greatly during the past two and one half centuries

A third important point which is not understood by the majority of surgeons dealing with these problems is that venous conditions of the lower extremities represent chronic ailments from altered venous physiology and as a result more than the usual post-operative care and follow-up of the patient is necessary for the best results

For success in this field of surgery there are few conditions which require a more thorough knowledge of the fundamental details of good surgical technique because failure to adhere to them may leave the patient in a worse condition than when he presented himself Nothing can be more tragic than a post-operative death following surgery for any of these conditions because few of them if untreated are lethal Death should never occur if the rules as laid down in this book are adhered to

It is a pleasure to write this foreword for what is believed to be the best book available on this subject The publication of it at this time certainly fills a definite need, and it is hoped that many surgeons now attempting this type of surgery will read it and digest its words with great care The explanations of the pathological physiology of the various disorders are fundamental and lucid in all details The surgical measures to correct them are carefully explained The only criticism, perhaps, of the book is the fact that some of the methods as described are not sufficiently radical to produce the best results, and it is predicted that in the next edition, especially in the handling of the chronic ulcers of the lower leg, a still more radical approach will be described in order to interrupt additional communicating veins, than those described in the text

Finally, it is to be re-emphasised that the operative procedure for these conditions is only a part of the treatment, since a careful follow-up with attention to recurrent or persistent varicose veins, secondary lymphedema, or dermatitis is of utmost importance for the obtaining of best results When properly handled, patients with these distressing conditions who are cured or relieved of them are some of the most grateful of surgical patients As most of them live for many years, they are living evidence of the skill and ability of the surgeon who can accomplish these ends, so unlike patients with malignant disease who so frequently live such a short time, despite the performance of the most brilliant surgical procedures

R R Linton

Boston, Massachusetts,
1956

PREFACE

Since 1930 diseases of the venous system of the leg have been investigated intensively Such advances have been made in the understanding of the pathology of deep vein thrombosis pulmonary embolism the post thrombotic syndrome and varicose veins that we feel the time has come for an attempt to collect this new knowledge in monograph form Further this subject is of importance to the comfort and activity of mankind By applying the underlying principles it is now possible to offer patients with disorders of the veins of the lower limb a good hope of cure

We have written with the practical aspects of the subject in mind No finer training ground for surgery is to be found than in dealing with venous conditions The diagnosis of the exact venous fault needs clinical skill and thoroughness The operative procedures though often considered trivial are actually a testing exercise in exact dissection and good surgical technique, which when mastered largely overcome the difficulties of more extensive procedures such as those on the thyroid the pancreas etc The after care of the patient is of great interest and importance It is therefore for the young trainee surgeon that we hope this book will hold a special message However the manifestations of diseases of the veins especially the deep veins are seen and have to be treated by every sort of doctor from general practitioner to dermatologist or consulting physician and in the sections on thrombosis, embolism, and ulceration of the leg its diagnosis and treatment, we hope that these also will find matter of interest

Finally we have an apology to the language purists It is for the word Venography which is used throughout this book instead of its possibly more correct synonym Phlebography After much discussion and consultation we felt that the more " plebeian venography was blessed by common usage and was therefore preferable

It is a pleasure to acknowledge the generous assistance of our friends in the production of this book especially to Dr S T Anning M A M D M.R.C.P for his chapter on the History of Varicosis and to Mr Charles I Murphie F R.C.S for his chapter on the Physiology of the Venous Circulation and for his help with the proofs We would also like to acknowledge our debt to Dr R R Linton of Boston for reading and criticising many of the chapters and for writing our foreword. It has been a particular pleasure to be associated with him and through him with the Massachusetts General Hospital where much original work on this subject has been done

Mrs Turner Warwick and Messrs Faber & Faber kindly gave us permission to extract freely from W Turner Warwick s classic on Varicose Veins, 1931

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We acknowledge the gracious permission of Her Majesty the Queen, to photograph the Leonardo da Vinci originals in the Royal Collection at Windsor Castle

Finally, we should like to acknowledge the many hours of work by our various secretaries

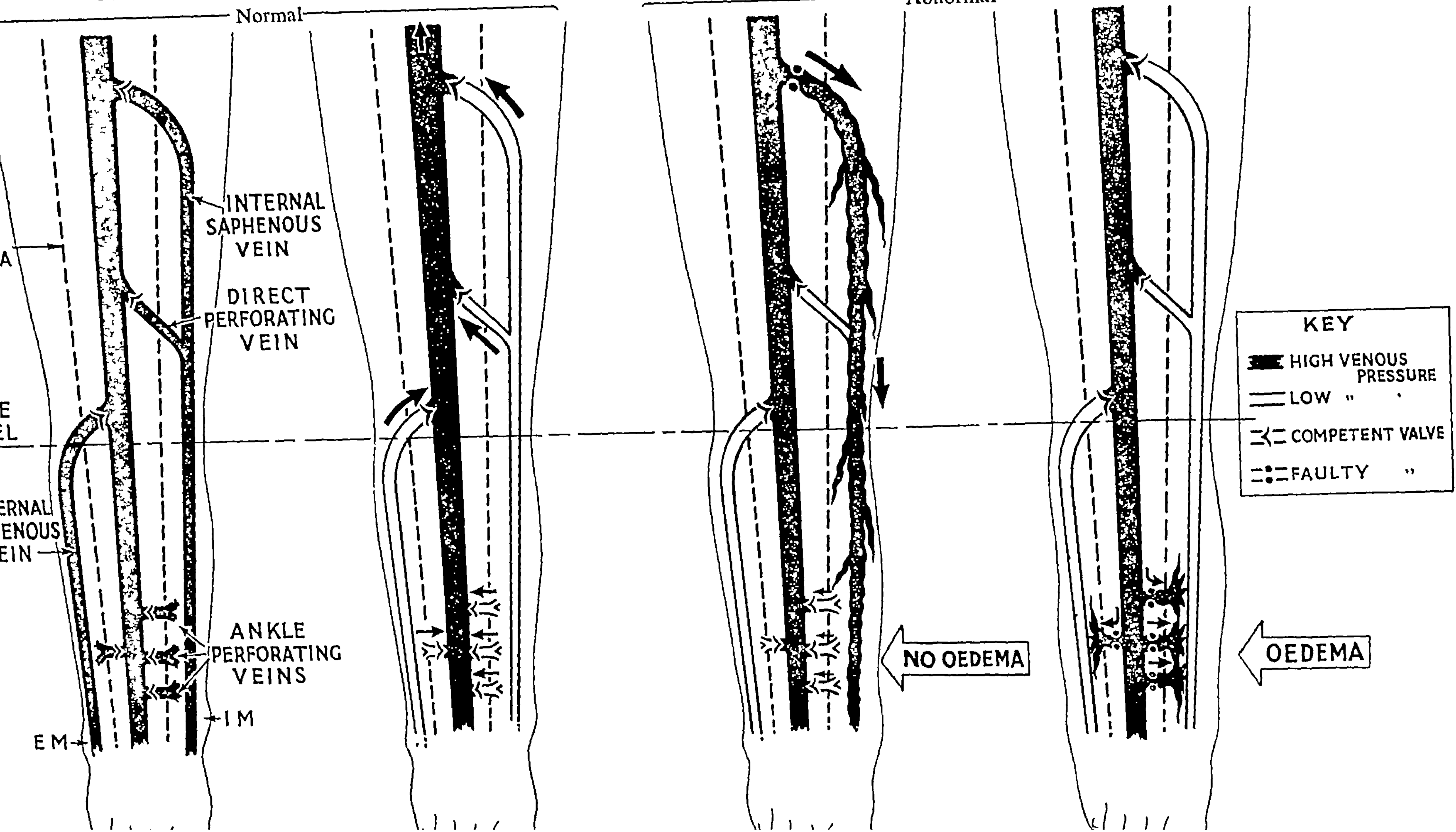
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London,
May, 1956

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CHAPTER 1

INTRODUCTION

VARICOSE veins are one of the commonest ailments of Western peoples probably one in five women and one in fifteen men over the age of forty five have them. Gunnar Bauer (1950) says, " It has been estimated that there are ten times as many sufferers from chronic venous disease of the lower extremities as from arterial disease with leg symptoms

Varicose veins are so numerous that only by every general surgeon having special knowledge and training in them and their associated conditions and accepting his share of their care can the community's need in this respect be met The reward is prompt, much lasting comfort is bestowed on individuals and their families and more personnel will be available for the country s activities The operations for varicose veins are exacting, but the technical skill acquired is valuable in more major procedures

We would say that every bad" leg can be materially improved by systematic diagnosis and planned treatment.

The actual cause of varicose veins is still unknown but the more exact knowledge of the anatomy of the venous system of the leg, and the physiological mechanism whereby venous blood returns to the heart against gravity have provided clearer understanding of the pathology and of the disorders that medical men are called upon to treat

Venous valvular failure and superficial venous hypertension.—Perhaps the most important of these studies has been on the behaviour of the venous pressure of the superficial and deep veins of the lower limbs in the erect position during rest and exercise and on the function of the muscular venous pump They have brought forth a clear and simple concept of the basic physiological mechanism at fault in varicose veins (Fig 1)

The fundamental fact to grasp is that the venous drainage of the superficial tissues in the *erect exercising leg* is *inwards* to the deep veins via the various perforating or communicating veins While exercising, the pressure in the main deep venous trunks is high but the pressure in normal superficial veins gradually falls to nearly zero In other words the blood in the superficial veins is sucked inwards to the deep veins of the limb during muscular movement and from these it is squeezed up towards the heart. What prevents this high pressure in the deep veins from being transmitted to the superficial veins during exercise? The answer is that at every point where a superficial vein joins a deep vein (great saphenous small saphenous and all the communicating or perforating veins) there is a valve which prevents the reflux of blood from the deep to the superficial system These valves prevent the hypertension in the deep veins from being transmitted to the superficial veins

The primary cause of the development of the varicosis in the superficial veins lies in the destruction of the strategic valves in the perforating veins This allows the *normal* high venous pressure developing within the musculo-fascial sheath during muscular activity to pass out and be exerted on the poorly supported superficial veins, resulting in an ambulatory venous hypertension in the affected group of superficial veins This sustained venous hypertension in the superficial veins during movement and standing results in their gradual stretching, enlargement, and tortuosity, a process which goes on steadily over the years, until the original valvular leak is found and stopped by surgery In fact the surgical aim in venous defects and their complications is to diagnose the site of the high pressure " leak " from the deep veins into the superficial veins and to close it by ligation *at its source*

The comparative degree of superficial venous hypertension.—There is one further fundamental point The ambulatory venous pressure which is transmitted outwards by a leak *high* in the limb, as at the sapheno-femoral junction, is less than that which is transmitted out by a faulty perforating vein at the ankle level Further, the leak at the sapheno-femoral junction is into a large vein, the internal saphenous, with its numerous and considerable tributaries which can " disseminate " the pressure readily and widely The leak at the lower leg level, by the ankle perforating veins, is by a short wide vein or veins which drain fairly directly into an adjacent capillary bed Hence for these reasons the effect of a pressure leak at the ankle level is likely to be more destructive than one from higher in the limb This concept is of great importance in understanding the pathology of ankle ulceration

The cause of venous valvular failure.—Thrombosis is an important and probably the most common cause of valve destruction in the perforating veins in the lower part of the limb But we are still uncertain what exactly causes the highest saphenous valve to become incompetent or destroyed in an early case of great saphenous incompetence

Heredity undoubtedly plays a great part in the genesis of varicose veins Whether a particular anatomical arrangement of valves, which predisposes to the throwing of great strain on the highest saphenous valve (pp 48 to 50) is inherited, or whether it is an actual weakness of the vein wall, it is impossible to say Both factors probably play a part

DEFINITION —A varicose vein is one which has permanently lost its valvular efficiency Venous distension and dilation, especially in the erect position, exaggerates this valvular incompetence Even when some patients are horizontal, their varicose veins *do not* shrink as do healthy ones As a result of continuous dilatation under pressure in the course of time a varicose vein becomes elongated, tortuous, pouched, thickened, inelastic and friable

The term " varicosity " is applied generally to those superficial vessels so affected in the lower limbs, but similar changes may also occur in veins in

the anal canal as haemorrhoids, and less often in the termination of the left spermatic cord as a varicocele Other rarer varices arise elsewhere, *e g* in the broad ligament, and in cases of portal hypertension at the lower end of the oesophagus

Varicosities in the lower limbs by far out number all similar venous disorders and the purpose of this monograph is to describe these and their allied conditions

The progressiveness of varicose veins.—The progressive nature of varicosis whilst it is connected with a source of hypertension merits emphasis. It becomes steadily worse and is a threat to the well-being of the person Further after apparently successful treatment, similar changes are apt to occur in other veins when another source of hypertension appears or enlarges especially with pregnancy or after the age of forty-five years Such new varicose veins are prone to be referred to as *recurrences* The treatment for varicosis may never be complete we have seen persons over seventy assert that their varices were a recent development.

Because of this progressiveness, patients, after treatment for varicosities are supervised once or twice a year for at least five years

The irreversibility of varicose veins.—In our experience when a vein becomes varicose it remains so even though the inefficient communicating vein *e g* one or other of the saphenous veins is removed Admittedly after such a ligature the remaining varicose veins shrink in size and may even thrombose, but after one to five years some veins refill and again constitute a disfigurement. The irreversibility of the varicose change guides our attitude to the disease. Sources of the high intravenous pressure must be cut-off and the prominent varices eliminated

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CHAPTER II

THE HISTORICAL ASPECTS

by

S T ANNING, *T.D* , M A , M D (Camb), M R C P

THE study of medical history enables the growth of knowledge an development of certain concepts to be traced This is well demons by consideration of the historical aspects of varicose veins, v thrombosis and ulceration of the leg, for from early times these cond have been described and theories as to cause expounded In miniature the evoluti medical thought through the ages can l lustrated



FIG 2
Votive relief
Man holding a huge leg showing varicose veins From the Asklepieion, Athens, now in the National Museum, Athens (Laignel-Lavastine *Histoire de la Médecine*, I Paris, 1936 Albin Michel éditeur, 22 Rue Huyghens, Paris)

EARLY WRITERS

The papyrus of Ebers (c 1550 B C) tions varicose veins and the author ac against operation for this condition (M 1954) Hippocrates (460 - 377 B C) assoc ulcers on the legs with enlarged veins and w " In the case of an ulcer, it is not expedie stand, more especially if the ulcer be siti in the leg " He believed that the Scythians, result of horse-riding, were afflicted with cosity of the veins because their feet were al hanging down from their mounts He also r that varicose veins of the legs do not o before puberty Hippocrates described the of compressive bandages and is somet quoted as advising small punctures in vari veins which should not be opened freely ' generally large ulcers are the consequence of incisions " However, this last advice appeai *De Ulceribus,* a book which is not now acce as part of the authentic Hippocratic collect

Varicose veins are illustrated on a vc tablet from the Asklepieion in Athens (Fig and an early account of a patient with this co tion, which appears in Plutarch's *Lives,* is of Caius Marius, the Roman tyrant who died in 86 B C. He underv operation for his varicose veins —

Marius is praised for both temperance and endurance, of which latter he gave a decided instance in an operation of surgery For having, as it seems, both his legs full of great tumours, and disliking the deformity he determined to put himself into the hands of an operator, when without being tied, he stretched out one of his legs, and silently without changing countenance, endured most excessive torments in the cutting, never either flinching or complaining but when the surgeon went to the other he declined to have it done, saying, "I see the cure is not worth the pain." (Clough, 1859)

Much was written about these conditions in Roman times Aurelius Cornelius Celsus (25 B C. A.D 50) advised the use of plasters for leg ulcers and linen roller bandages Varicose veins were to be treated by exposure followed by avulsion with a blunt hook or by a touch of the cautery

Claudius Galen (A.D 130 200) also tore out varicose veins with a blunt hook. He applied wine to leg ulcers and was opposed to frequent changes of the dressing. Juvenal, almost his contemporary mentioned about A.D 115 that the 'soothsayer [with so much standing about] will soon be troubled with varicose veins

The first to ligate varicose veins seems to have been the Byzantine physician Aetius of Amida on the Tigris (502 575) Paulus Aegineta (607 690) also performed this operation but preferred to carry out ligation of veins on the inner part of the thighs "where they generally arise '



[illegible] Phœbi [illegible] vertice monstrat,
Ægrotis medicam tradere doctus opem.

H. Sw

FIG. 3
Jean Fernel (1506 1588)
From the reverse of the title-page of his *Therapeutices universalis seu medendi rationis libri septem*. Frankfurt, 1574

THE HUMORAL THEORY

Galen's theory of humours taken from Hippocrates, together with his idea of the to-and-fro movement of blood with its various spirits dominated medical thought for fifteen centuries Varices were attributed to the weight of stagnant "gross blood on the walls of veins Haly Abbas (d. 994) believed that they were filled with a black bile and occurred in those who worked hard and stood long. Being outside the main venous channels the deleterious humours were thought to be side-tracked and safe unless pressed back by bandaging They might then lead to madness or other disasters (Cf Hippocrates aphorism "Varicose veins or haemorrhoids appearing in a case of madness put an end to it.")

The cause of the thickening of the blood which led to varices was considered by Fernel (1604) (Fig 3) in his book *Pathologia* He wrote " It [the varix] comes also from a blow, from a contusion, from excessive effort, from hard work and much travelling, sometimes from 'plethora' as in most pregnant women " Child-bearing and " standing too much before kings " were believed by Marianus Sanctus of Barletta (1555) to be the chief causes of varicose veins and another surgeon, Paré (Fig. 4), writing in 1579 on the aetiology of varicose veins said " The matter of them is usually melancholy blood, for varices often grow in men of a melancholy temper, and which usually feed on gross meats, or such as breed gross and melancholy humours Also women with child are commonly troubled with them, by reason of the heaping together of their suppressed menstrual evacuation The precedent causes are a vehement concussion of the body, leaping, running, a painful journey on foot, a fall, the carrying of a heavy burden, torture or racking It is best not to meddle with such as are inveterate, for of such being cured there is to be feared a reflux of the melancholly bloud to the noble parts, whence there may be imminent danger of malign ulcers, a cancer, madness or suffocation " (Paré) Pigeaux, as late as 1843, wrote of a cook who several times had abortions because her varicose veins were bandaged during pregnancies



FIG 4
Ambroise Pare (1510 - 1590)

Fernel (1604) referred to oedematous ulcers caused by the collection of corrupt humours and Vicary (1536) (Fig 5) noted that " the Legges when they are offended or wounded, are very perillous, because unto them runneth a great quantity of humors," and he added that they are " troublesome and curious to heale " Based on the humoral theory the view was held that it would be risky to cure a leg ulcer, though Hippocrates, Celsus, Galen, Aetius of Amida and Paulus Aegineta had no such inhibitions However, Avicenna (980 - 1037) believed that ulcers in old people should not be healed and if healed should be broken down Even in the eighteenth century Le Dran (1731) in France and Heister (1768) in Germany took a similar view and considered the ulcer to be a drain for humours which, if not expelled, would cause serious illness Sharp in 1758 wrote that " in old people the cure is often dangerous " Benjamin Bell (1789), however, was prepared to believe that, with a small degree of caution, the cure of every ulcer may be attempted As late as 1801 Home could write " If a patient of a gouty habit has an ulcer on the leg

any attempt to heal the ulcer is improper" and Buchan (1822) expressed himself forcibly on this subject —

If an ulcer conduces to the patient's health *from whatever cause it proceeds*, it ought not to be healed, but if on the contrary it wastes the strength and consumes the patient by a slow fever it should be healed as soon as possible.



FIG 5
Thomas Vicary (1495 1561)
From an impression in the Wellcome Collection of an *etching after the picture by Holbein representing the* Union of the Barbers and Surgeons.

We would earnestly recommend a strict attention to these particulars to all who have the misfortune to labour under this disorder particularly persons in the decline of life as we have frequently known people throw away their lives by want of it, while they were extolling and generously rewarding those whom they ought to have looked upon as their executioners

In 1859 Hunt remarked that many patients still believed that the ulcer was salutary, and that it could not be healed without risk of damage to the general health, though he referred to it as an unfounded and now almost obsolete prejudice Nevertheless, even today in country districts old women may be found who firmly believe in the danger of healing leg ulcers



FIG 6
Sir Astley Paston Cooper (1768 - 1841)
From the engraving by W H Mote after a portrait by T Lawrence Engraving in the Wellcome Historical Medical Museum

Derived from the humoral theory was the idea of menstrual ulcers "Many," wrote Barbette (1675), "by a Suppression of the Menstruals fall into a melancholy Madness, as we have twice observed Many great Diseases, as a Cachexy, Dropsie, Cardialgy, Swoonding, Palpitation of the Heart, Madness, Gout, Dizziness, Falling-sickness, Apoplexy, etc do proceed from a Suppression of the Menstruals" Moreover, the menstrual blood, collecting in the legs during pregnancy becomes stagnant and, in order to allow its escape, ulceration follows Writers in the seventeenth and eighteenth century (*e.g*, Ettmuller, 1688) continued to believe that menstrual blood is "gross" and collects in the legs during pregnancy causing varicose veins and ulcers Astruc (1761) seems to have been the first to state clearly that menstrual

blood is not a collection of bad humours Even in the first half of last century Sir Astley Cooper (1824) (Fig. 6) and Critchett (1849) wrote of menstrual ulcers related to amenorrhoea from any cause and prior to the investigations of Davis (1822) post-partum venous thrombosis was explained in terms of the humoral theory



Fig. 7
Richard Wiseman (1622 1676)

The lochia were considered to be bad humours whose retention often occurs during puerperal fever and is likely to cause trouble In 1603 Roderiguez a Castro published his work *De Universa Mulierum Morborum Medicina* He not only considered the swollen and livid legs of pregnant women but made observations concerning swellings of the lower extremities in the puerperium "vidimus crurum tumores post partum contingere si lochia minus copiosa procedant."* He considered that immoderate drinking after child-birth precipitated the trouble and made the important observation that it might occur after copious bleeding.

* After childbirth we observe swelling of the legs to occur when the lochia flow less copiously

In this country post-partum thrombosis was first described in 1676 by Richard Wiseman, Sergeant-Chirurgian to Charles II (Fig 7) In a chapter on *Abscesses and Corrosive Ulcers Arising From Distempers of the Uterus in Child-bed,* he relates the following history —



FIG 8
Armand Trousseau (1801 - 1867)
From a lithograph

An Apothecary's wife, living in my Neighbourhood in the Old Bailey, after a hard Child-bed labour was seized with a Fever, and great pain in her right Thigh, from the Groin and Hip downward to the Knee, swelling the Member round, without inflammation or discolouring the skin

Wiseman did not speculate about the causes of the condition and, although familiar with venous thrombosis, did not relate the two

Another theory to explain the swelling of the limb in phlegmasia dolens was put forward by Puzos (1759) and owed much to the idea of humours He considered that milk is formed in women during pregnancy, as well as after delivery, and is directed principally to the uterus in the former, and to the breasts later When the *foetus in utero* or the infant at the breast cannot consume the whole of the milk that is formed, the excess escapes in the excretions or collects in certain parts of the body and particularly in the lower limbs

In 1784 Charles White who was "man-midwife extraordinary to the Manchester Lying-in Hospital" published a tract on the swelling in one or both of the lower extremities during the puerperium. He wrote that it was "not owing to any defect of the lochia as it happens to those who have the most regular discharge" "nor to a deposit of milk as it happens under every circumstance attending that secretion" He thought "that the proximate cause of this disorder is an obstruction detention and accumulation of lymph in the limb brought about by rupture of the lymphatics from pressure of the foetus s head" during labour (a mechanical cause) and he did not believe that it occurred under other conditions than parturition.

The credit must go to Davis of Queen Charlotte s Hospital for first appreciating that the veins were the seat of the trouble. He published in 1822 a remarkable paper on *The Proximate Cause of Phlegmasia Dolens* which he showed to result from a "violent inflammation of one or more of the principle veins within and in the immediate neighbourhod of the pelvis" Phlegmasia dolens following typhus fever (Ferriar 1810) and injury (Hodgson 1815) were described. Trousseau (1865) gave a masterly lecture on the subject (Fig. 8)

THE MECHANICAL THEORY

However a fundamental blow to the humoral theory had been struck when Harvey wrote of his discovery of the circulation of the blood (1628) (Fig. 9) He had reached his conclusions after studying the valves in veins, appreciating that, in a vessel containing valves, a to-and-fro movement of blood is not possible.



Fig. 9
William Harvey (1578 1657)
From the line engraving by J Hall after the picture in the Royal College of Physicians.

Wiseman (1676) realised that valvular incompetence results from dilatation of a vein and although the association of varicose veins and leg ulcers had been noted by Hippocrates, he seems to have been the first to consider that ulcers might be the direct result of a circulatory defect and used the term varicous ulcer

It is noteworthy that many eighteenth century writers on leg ulcers such as Underwood (1783) Bell (1789) Baynton (1797) and

Whately (1799), made no reference to varicose veins as a cause New ideas were growing Probably chiefly influenced by Newton's *Principia* (1687) and by Morgan's book on *The Philosophical Principles of Medicine* (1725), which was based on it, there were many adherents to the iatromechanical doctrines which viewed the body as a machine with pumps, tubes and valves and with



FIG 10
Sir Benjamin Brodie (1783 - 1862)

levers of bones and joints activated by muscles For example, Quincy (1722) in the preface to his *Lexicon Physico-Medicum* wrote "And because what is brought from Physicks and Mechanicks takes up so much room here, it may be necessary to inform the Reader, that there is no Knowledge in Medicine but by such means" We have seen that White's theory of the cause of phlegmasia dolens was mechanical and Dionis (1708) attributed the varicose veins in pregnant women to the pressure of the uterus on the iliac veins

The mechanical theory was applied to ulcers Thus Sharp in 1758 wrote "The Indisposition of these Sores is in some measure owing to the Gravita-

tion of the Humours downwards and in 1797 Baynton declared that the disease arises " from the unfavourable situation of the parts which are placed at a remote distance in the human machine from the fountain of life and heat, and are obliged to return the venous blood and lymph to the heart under some peculiarly unfavourable and disadvantageous circumstances " Two



FIG. 11
John Hilton (1804 1878)

years later Whately had written that ' when the body is erect, the blood and lymph return from the extremities contrary to their gravity in a column of several feet."

During the nineteenth century however the emphasis was on varicose veins as the cause of leg ulcers and the term varicose ulcer " scarcely used since Wiseman s day became established Home (1801) believed an ulcer was more difficult to heal if there were varicose veins and Hodgson (1815) wrote of ulcers which are generally situated near the ankle, and are remarkably intractable They appear to depend," he thought, upon the varicose con ditions of the veins for when the latter is relieved the ulcers are as readily cured as ulcers in general " Many writers of the nineteenth century—Brodie (Fig. 10) Cooper Critchett, Hilton (Fig 11) Hunt Scott and others—stressed the importance of varicose veins, but Gay (Fig. 12) and Spender both writing in 1868 believed that venous thrombosis also played an important part and

Gay pointed out that severe varicosity may exist without ulceration Indeed, Gay denied the validity of the doctrine of the varicose ulcer and thought, like Chapman (1853), that the term should be discarded



FIG 12
John Gay (1812 - 1885)

THE PATHO-PHYSIOLOGICAL APPROACH

Gay's work appears to have been the first scientific investigation of these conditions in this country though in France Verneuil (1855) had made careful observations and dissections Gay pointed out that with superficial varicosity there may be other serious lesions affecting both arteries and veins, deep and superficial, which cannot be ignored, and he considered that —

Ulceration is not a direct consequence of varicosity, but of other conditions of the venous system with which varicosity is not infrequently a complication, but without which neither one of the allied skin affections [induration and bronzing] is met with, conditions which involve obstruction of the trunk veins, deep and

superficial, either from impediments on the venous side, or incompetency on the arterial, or from both causes combined

The truth of these statements has become manifest in the last decade during which the importance of deep venous thrombosis and arterial disease in the aetiology of leg ulcers has become more generally appreciated Interest is now taken in the circulation of blood through the limb as a whole The effect of muscular contraction in assisting the flow of venous blood, especially from the lower limb was understood by Harvey (1628) and Lower (1670) but until recently the concept of a "leg muscle pump has attracted little attention

Rational treatment is based on aetiology Different theories attempting to explain the cause of a disease inevitably have their influence on therapy even though much of it is empirical This is clearly seen when the subject of treatment is approached historically

TREATMENT

In considering the historical aspects of treatment we shall deal primarily with leg ulcers and must take into account four methods treatment by compression of the limb local treatment of the ulcer the surgical treatment of varicose veins and the general treatment of the patient



FIG. 13
Henri de Mondeville (1260-1320) lecturing to his pupils From a manuscript of his *Chirurgia* (1314), in the Bibliothèque Nationale, Paris.

Compression.—The value of firm compression of the leg was appreciated early and we have mentioned that linen roller bandages were used by Celsus. Henri de Mondeville (Fig 13) writing between 1306 and 1320 thought that a bandage embracing the whole limb was advantageous because it " drives back the evil harmful humours infiltrated in the leg and the ulcer and " it, moreover prevents and stops the flow of humours tending to come." Guy de Chauliac (1363) (Fig. 14) used diachylon plaster bandages very similar to those employed by Marianus Sanctus of Barletta (1555) Baynton (1797) Brodie (1846) and by doctors nowadays Ambroise Paré taken prisoner in the campaign of 1553 when acting as surgeon to Henri II cured the leg ulcer of

Lord Vaudeville, his captor, though it had been present six or seven years After local treatment he "roule the Leg beginning at the foote, and finishing at the knee, not forgetting a little bolster upon the Varicous veine" He also used local compression with a lead plate but insisted on rest in bed "which is commanded by Hippocrates"



FIG 14
Guy de Chauliac (1298 - 1368)
From the engraving by Ambroise Tardieu after the picture in the Ecole de Médicine, Paris

Wiseman (1676) introduced a new method of compressing the leg affected by leg ulcers—a laced stocking usually made of soft leather such as dog skin (Fig 15) This became widely used both in this country and on the Continent Petit (1790) preferred this method as the degree of compression can be varied by the lacing Wiseman also mentioned bandaging but it does not seem to have been in general use—certainly not in 1771 when Else wrote: "About two years and a half ago, in a conversation with Dr Huck upon this subject, he told me, that Mr. Battiscombe, apothecary, in Half-moon-street, Piccadilly, had a very speedy method of curing sore legs, one remarkable instance of

which he had lately seen and had heard of others The case which fallen within his knowledge was that of a servant-maid who had labo under a very bad painful ulcer of the leg for twelve or fourteen years had come out of two hospitals without her cure Dr Huck said that he not know the whole of Mr Battiscombe s method but that he believed the principal part of it consisted in the application of a tight bandage He said that Mr Battiscombe first applied a linen rag moistened with a liquor which was probably tincture of myrrh that over this he applied a thin plate of lead, and then a roller very tight from the toes to above the knee I immediately recollected that Mr Battiscombe had cured a grenadier and an officer s servant, of ulcers in the legs, which I thought would be difficult to heal without rest, and therefore advised them to go into an hospital Mr Martin, my colleague in St. Thomas's Hospital and I determined to try what bandage would do in old ulcers of the legs without administering any internal medicine and find it so exceedingly efficacious that I believe it will seldom fail where there is no carious bone He thought that a tight roller bandage applied from the toes to the knee was much better than a laced stocking

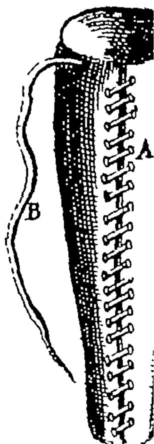


FIG. 15
Richard Wiseman s le stocking (from He 1768)

Underwood (1783) wrote on the treatment of ulcers without rest and used Welch flannel" for bandaging as he found it elastic In the nineteenth century Brodie Hunt and Spender gave excellent accounts of the treatment of ulcers by bandaging and Cooper (1824) believed that compression allows the venous valves to recover their lost action Two important advanc recent times have been the introduction of the elastic adhesive bandag Dickson Wright (1930) and the combination of firm massage and e webbing bandages to reduce oedema and induration (Bisgaard, 1948)

Local treatment.—From the time of Celsus details are known of applications used in the treatment of leg ulcers Though methods altered the principles of treatment have changed little. In place of the applied to ulcers by Galen we use other antiseptics and, though Paré surgeons after him placed lead plates over ulcers silver foil is now being (Milberg and Tolmach 1954) Critchett in 1849 covered ulcers wit lining membrane of egg-shells and in 1950 Troensegaard Hansen used am The eighteenth century surgeon cleansed the ulcer of slough by a dig application and in 1954 Spier and Clifton used plasminogen and streptok

Nevertheless, the growing use of the microscope and the advance of bacteriology had a great influence on the local treatment of leg ulcers From the time of Lister the control of micro-organisms on the surface of leg ulcers by means of antiseptics became of increasing interest Inevitably an ulcer becomes secondarily infected with various organisms commonly present on the skin but there is rarely any relationship between the type of infection or the number of bacteria in the ulcerated area and the slowness or rapidity with which the ulcer heals As Dickson Wright (1930) showed, a leg ulcer will heal although infected if the oedema is abolished, local treatment is of secondary importance "But," to quote from Le Clerc (1723), "as all these methods are sometimes useless and as there are some ulcers which need the hand of the surgeon, Celsus also teaches in particular a method of curing them by operation"

Surgical treatment of varicose veins.—We have mentioned that Celsus and Galen tore out varicose veins after they had been exposed and that Aetius of Amida seems to have been the first to use ligation Paulus Aeginata gave careful directions for this operation

Wherefore, having washed the man, and applied a ligature round the upper part of the thigh, we are to direct him to walk about, and when the vein becomes distended we are to mark its situation with writing ink or collyrium, to the extent of three fingers' breadth or a little more, and having placed the man in a reclining posture with his leg extended, we apply another ligature above the knee, and where the vein is distended we make an incision upon the mark with a scalpel, but not to a greater depth than the thickness of the skin, lest we divide the vein; and having separated the lips of the wound with hooks, and dissected away the membranes with crooked specilla, like those used in the operation for hydrocoele, and laid bare the vein, and freed it all round, we loose the ligatures from the thigh, and having raised the vessel with a blind hook, and introduced under it a needle having a double thread we cut the double of it, and opening the vein in the middle with a lancet, evacuate as much blood as may be required Then having tied the upper part of the vessel with one of the ligatures, and stretched the leg, we evacuate the blood in the limb by compression with the hands Then having tied the lower part of the vein, we may either cut out the portion intermediate between the ligatures, or suffer it to remain until it drops out of its own accord with the ligatures, then we have to put a dry pledget into the wound, and apply over it an oblong compress soaked in wine and oil, and secure them with a bandage, and accomplish the cure by the treatment applicable in cases of suppuration

The descriptions of the operative procedures of later writers are remarkably similar Though nowadays ligation of the internal saphenous vein in the thigh is usually associated with the name of Friedrich Trendelenburg (1844 - 1924) (Fig 16), Paré had practised the operation in the sixteenth century, followed 200 years later by Rima (1777 - 1843)

But ligation alone was not sufficient for adherents of the humoral theory The "gross" blood must be removed. Thus Fabricius ab Aquapendente (1533 1619) (Fig. 17) tied the vein above and below the varix and having evacuated its contents by puncturing the latter obliterated the cavity by compression



FIG. 16
Friedrich Trendelenburg (1844 1925).

Paré however clearly recognised the presence of thrombophlebitis in a superficial varicose vein when he wrote —

They often swell with congealed and dryed bloud, and cause pain which is increased by going and compression Such like varices are to be opened by dividing the veine with a Lancet, and then the blood must be pressed out, and evacuated by pressing it upwards and downwards which I have oft times done, and that with happy success *to the Patient*, whom I have made to rest for some dayes and have applyed convenient medicine.

But he also wrote that " a Varix is therefore cut or taken away so to intercept the passage of the bloud and humours mixed together therewith, flowing to an ulcer seated beneath " (Paré)

Dionis (1708), like Fabricius, recommended, as one method of treating varices, that the vein should be punctured, the blood removed and compres-



FIG 17

Hieronymus Fabricius ab Aquapendente (c 1533 - 1619) From the line-engraving after the anonymous picture in the Padua Anatomy School

sion applied Heister in 1739 believed that the worst of the varices should be opened " by a longitudinal Incision with the Scalpel, or a Lancet then taking away about eight or ten Ounces of the grumous and viscid Blood " (Heister, 1768) Petit (1790) also insisted on the efficacy of puncturing varices with a lancet During the bleeding the limb was gently massaged so as " to press out the thick black blood " As James wrote in 1743 —

The smaller Kinds of Varices usually create but little Uneasiness, and are, therefore, neglected by the Patient, as not requiring the Assistance of the Surgeon

In order, however, to prevent a small, and, at first, Inconsiderable Evil, from increasing by degrees, and growing formidable, to the great Detriment, and Annoyance of the Patient, it is adviseable to open a Vein, with all Speed, and take away a Quantity of Blood, and, after that, to prescribe a proper Regimen of Diet:

This done, it will be convenient to secure the diseased Feet in the most careful and exact manner with a repellent or as it is commonly called, expulsive Bandage.

In 1816 Brodie because the necessity of withdrawing "gross" blood had by this time disappeared merely divided the varicose vein subcutaneously with a bistoury However in the past, the surgical treatment of varicose veins does not seem to have been popular and Wiseman (1676) with Caius Marius in mind, wrote "I have never met with one Patient that cared to hear of the Cure by Ligature, nor indeed have I seen any great reason for it."

Apart from the question of the patient's suffering during the operation the complication of sepsis made it highly dangerous. Cooper (1824) stated that no fewer than eight cases terminating fatally after ligature had come to his knowledge and Chapman (1864) wrote —

One of these accidents, it is said, happened in the practice of Sir Astley himself some months after he had roundly declared that a surgeon who performed such an operation deserved to have a ligature applied round his own neck.

Home (1801) Hodgson (1815) Brodie (1816) and other authors also stressed the dangers of ligation dangers which were diminished by the advent of antiseptic surgery following the teaching of Lister and which were almost eradicated when the importance of asepsis became recognised.

Percutaneous ligation was introduced and discarded in the nineteenth century though an author in 1943 described it as his own invention. Davat (1833) passed several needles through the skin and affected vein and then tied figure-of-eight ligatures around both ends of each needle This resulted in an inflammatory reaction in the vein and finally in its obliteration. Erichsen (1853) employed a slightly different method. He wrote —

The most convenient way of obliterating the varicose veins, in my opinion, and that which I always employ consists in compressing the vessel at several points, by passing a hare lip pin underneath it, laying a piece of wax bougie upon the vessel and then applying the twisted suture around the pin and over the bougie

Popliteal ligation must briefly be mentioned Hodgson (1815) had written "For the purpose of diminishing the length, and consequently the weight of the column, it has been proposed to obliterate a portion of the dilated vein by the application of a ligature Parona (1894) endeavouring to apply the theory of Verneuil (1855) that the deep veins are responsible for the superficial varices ligated the popliteal vein to cut off the hydrostatic pressure of the column in the femoral vein from the varicose veins below In recent years popliteal ligation has again been advocated by Bauer (1948)

Hodgson (1815) had noticed that coagulation of blood in veins "terminated in a spontaneous cure of varices." The vessel was ultimately obliterated, and the blood was conveyed through collateral vessels." A means of producing this coagulation at will was sought and "galvano-puncture" was used in Italy (Chapman 1864) The injection of substances directly into

a vein to produce thrombosis was, as Boyd (1948) said, "fortunately delayed until the introduction of the hypodermic syringe by Francis Rynd in 1845" Chapman (1864) wrote that "attempts have been made to obliterate varicose veins by injecting the perchloride of iron into them, and a French author, M Pravaz, reports very favourably of its action" He describes complications arising from this treatment, which until recently had a considerable vogue



FIG 18
John Hunter (1728 - 1793)
From the painting in the Royal College of Surgeons of England by Reynolds

Another development, reminiscent of Celsus with his blunt hook, is the stripping operation Keller (1905) removed the internal saphenous vein by passing through the vein a wire loop or probe with a ligature attached This was tied to the end of the vein and on pulling it the vein was extirpated. Mayo (1906) and Babcock (1907) used strippers with which the divided vein was pulled out

General treatment.—It has long been appreciated that the general treatment of the patient with a leg ulcer must not be neglected Octavius Horatianus directed such a one to avoid the bath, the fire, the sun, cold air, loud cries, intoxication, venery and passion

Inevitably the humoral theory had an influence on general treatment, an influence which persisted into the eighteenth century, an example of which is the enthusiasm of physicians of that period for bleeding their patients Heister (1768) had written in 1739 "To prevent the Disorder from running

to any great length it may be proper to bleed the Patient" and he advised "Abstinence and a strict Regimen in Diet."

Petit (1790) stressed the importance of general remedies, diet and rest in bed and Hunter (1835) (Fig. 18) considered that a horizontal posture with temperance, should be the first thing advised in sore legs especially in poor people suffering from bad living, much exercise and cold who benefit from the rest food and warmth when in hospital However Chapman (1853) took a different view and wrote ' Porter in moderation is almost always necessary in hospital cases, and in confirmed spirit drinkers no experienced surgeon would venture to prohibit altogether the accustomed stimulus "

CONCLUSION

The history of varicose veins and leg ulcers has been traced and we have noted the influence of the humoral and mechanical theories, and the pathophysiological approach to the subject both on views concerning the aetiology of these conditions and on methods of treatment.

Samuel Butler (1835 1902) wrote The history of art is the history of revivals It might well have been said of the history of medicine

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CHAPTER III

SURGICAL ANATOMY OF THE VEINS OF THE LOWER LIMB

INTRODUCTION

THE anatomy of the arterial system is relatively constant, but that of the venous system is subject to variations from person to person. This causes diverse effects and presentations of pathology Although the basic pattern is roughly the same, the variations are endless

The veins of the leg can be studied under five headings —

1. The structure of the vein wall
2. The superficial veins
3. The deep veins (inter- and intra-muscular)
4. The valves of these veins
5. The communicating veins, which connect 2 and 3

Structure of the vein wall.—The veins, like the arteries, have three coats —

1. The external or adventitia
2. The middle or media
3. The internal or intima

The external coat, absent in the sinuses of the dura mater and the fibro-elastic veins, is well developed in the muscular type veins of the lower limbs. It is made up predominantly of lax connective tissue, with lymphatics, tiny blood vessels (vasa vasorum), and some sympathetic nervous fibrils This laxity allows great variations in the capacity of the vein

The middle tunic varies considerably in its structure according to the size of the vein It consists of smooth muscle fibres, fibrous tissue, and a few elastic fibres In the main superficial veins, the great and small saphenous, this tunic is very thick and there is a predominance of smooth muscle Thus these veins are remarkable for their ability to contract and relax under appropriate stimuli, and also for their strength and ability to withstand high intravascular pressures The tributaries of these veins, being much less strongly made, rapidly dilate and become tortuous and varicose on exposure to sustained high intravascular pressures In cases of great saphenous incompetence these tributaries become dilated and tortuous long before the main channel shows such a change; in fact the trunk itself hardly ever becomes tortuous, although it may become dilated

On the other hand the media of the large deep venous trunks, the popliteal and femoral, has a high proportion of fibrous and elastic tissue and less

smooth muscle. Thus their power of contractility is limited (although present) They are comparatively rigid, and are supported by the fibrous sheaths which contain them and their accompanying artery and by the surrounding muscles.

The internal coat or intima differs little structurally from the internal arterial coat. It too is made up of endothelial cells on a sub-endothelial stratum of connective tissue with an internal elastic lamina. The essential difference between the intima of the arteries and that of the veins is that the latter possess valves which in health ensure the centripetal passage of the blood from the periphery towards the heart

THE SUPERFICIAL VENOUS SYSTEM

Drainage from the toes and foot (Fig 19) —Each toe has four digital veins two dorsal and two plantar

THE DORSAL DIGITAL VEINS join in the toe clefts to form the dorsal metatarsal veins which unite to form a dorsal venous arch The dorsal arch is linked with medial and lateral marginal veins which run along the inner and outer borders of the foot. Ultimately the internal part of the dorsal venous arch is continued upwards as the internal saphenous vein. The lateral marginal vein which is less well defined and smaller than its medial counterpart, communicates with the small saphenous vein by way of the venous plexus behind and below the external malleolus

THE PLANTAR DIGITAL VEINS form the four deep metatarsal veins which run between the metatarsal bones and unite to form the deep plantar venous arch which lies in association with the deep plantar arterial arch.

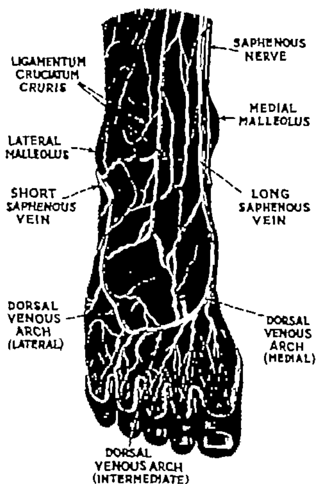


FIG. 19
Venous drainage of foot and ankle

The dorsal and plantar digital and metatarsal veins communicate with each other freely at the roots of the toes between the metatarsal bones The plantar digital veins also communicate with the adjacent super

ficial vessels in the sole of the foot to form a plantar subcutaneous venous arch which has numerous connections extending backwards to the veins of the heel, and by twigs to the lateral and medial marginal veins

THE HEEL —Beneath the skin of the heel there is a considerable venous plexus, which communicates by many small channels with the deep and superficial veins of the sole, and with the dorsal and plantar cutaneous veins

The long or internal saphenous vein (Fig 20) (*Syn great or large saphenous vein or saphena magna*)—The internal saphenous vein is the longest vein in the body. It is formed by the union of veins from the inner part of the foot and the medial marginal vein and runs upwards for 1 - 1½ inches in front of the medial malleolus of the tibia Thence it courses up the antero-internal part of the leg and thigh to end in the common femoral vein at the groin by passing through the foramen ovale, an opening in the deep fascia A thin prolongation of the femoral sheath passes down and ensheathes the last centimetre of the long saphenous vein, so that until it is dissected off, the foramen ovale is inconspicuous

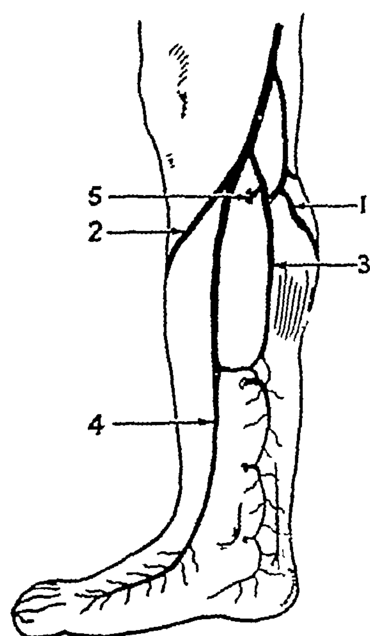


FIG 20
The Tributaries at or about Knee Level
1 The connection with the external saphenous vein 2 A tributary from the anterior surface of the leg 3 The posterior arch tributary which also links the three internal ankle perforating veins 4 The internal saphenous vein 5 A constant direct communicating vein

At the ankle the position of the long saphenous vein is fairly constant It lies in the groove between the anterior border of the medial malleolus and the tendon of tibialis anterior It ascends obliquely backward over the subcutaneous medial surface of the lower fourth of the tibia and along the medial border of this bone to the internal condyle at the knee Thence it sweeps over the *postero-medial aspect* of the knee joint and behind the medial condyle of the femur Above the knee it ascends slightly forwards upon the antero-internal aspect of the thigh and into the fossa ovalis, to join the common femoral vein

THE LANDMARK OF THE SAPHENO-FEMORAL JUNCTION —This is variously described. A reliable surface marking is 1 - 1¼ inches (2 5 cm - 3 25 cm) below and lateral to the pubic tubercle It is advisable to use this bony point in fat subjects as the fold of the groin is unreliable, the sapheno-femoral union being below this crease in thin people, and above it in the obese

THE INTERNAL SAPHENOUS VEIN AND THE DEEP FASCIA —The relation of the internal saphenous vein to the deep fascia is important surgically In the lower two-thirds of the leg and in the upper two-thirds of the thigh the vein lies on, and is closely applied to, the deep fascia About the knee, in 50 per

of cases it becomes more ficial and may be subular Because of this vely deep situation, the saphenous vein is gener invisible, except in spare ular limbs, and when it is enlarged.

THE STRUCTURES OMPANYING THE INTERNAL SAPHENOUS VEIN

In the foot and leg the enous nerve lies close e the saphenous vein It oaches this vein below the after it has pierced the -muscular roof of the ctor (sub-sartorial) canal ng between the tendons of sartorius and gracilis cles to gain the posterior medial aspect of the knee e it gradually approaches ong saphenous vein

At the knee the saphenous ch of the descending cular artery accompanies saphenous vein This may me a large and important ateral channel in cases re the femoral artery be es obstructed by throms in the region of the ad tor canal

In the thigh twigs of the al femoral cutaneous nerve in the vicinity of the vein ough they are not closely lied to it.

TRIBUTARIES AND COM NICATIONS OF THE INTERNAL HENOUS VEIN —Below the

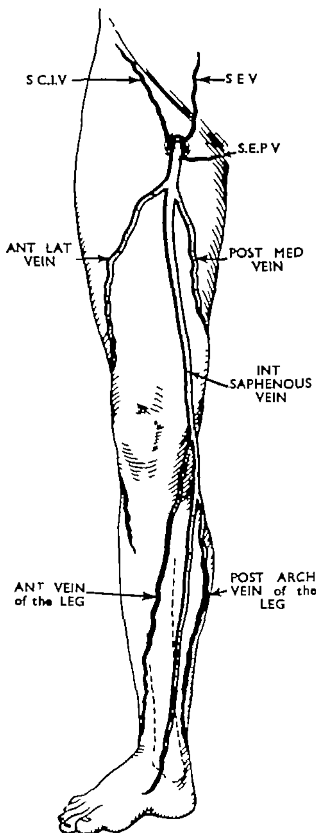


FIG. 21
The internal saphenous vein with its tributaries.
S.C I V = superficial circumflex iliac vein.
S.E.V = superficial epigastric vein
S.E.P V = superficial external pudic vein.

ankle this vein is fed by the medial marginal vein whose tributaries have already been described

In the leg the long saphenous vein itself has few tributaries There is a constant small connection between it and the upper of the three internal ankle perforating veins (Fig 20) and there may be one or two small tributaries from the anterior aspect of the leg joining it in its lower third Occasionally there is a small connection with the venous arch joining the internal ankle perforating veins There is a free anastomosis between a tributary or tributaries of the short saphenous vein and the venous arch connecting the internal ankle perforating veins, by a vein running behind the tendo-Achillis By this means the long and short saphenous systems are connected in the lower third of the leg These tributaries however, are small and subject to variation in number and size in various pathological states

Around the knee—The great saphenous vein runs from the ankle to the knee without any major constant tributary, but at the latter it generally receives three large vessels or groups (Figs 20 and 21)—(1) *A calf group* draining an area of the calf posteriorly, which connects with (and occasionally may replace) the small saphenous system joining it behind the knee joint (2) *An anterior vein of the leg,* which winds up from the dorsum of the foot, ankle, and anterior surface of the leg to join below the knee It also links with a perforating vein at the middle of the anterior tibial compartment of the leg (Fig 20)

(3) *The posterior-arch vein* from the inner malleolus, which is large and constant It arises from a series of small venous arches connecting the three internal ankle perforating veins, and passes up the medial surface of the leg to unite with the internal saphenous vein at the inner aspect of the knee This vein is of historical interest as it was depicted accurately by Leonardo da Vinci in one of his anatomical figures (Fig 22D)

In the thigh several small tributaries are received but the two largest are the postero-medial and antero-lateral veins joining close to its termination (These names seem to us more suitable and less confusing than their older titles which, amongst others, were called the internal and external superficial femoral veins) (Fig 21)

The postero-medial vein (also named by Bauer the femoro-popliteal vein) is of considerable size and is formed in part by a small vein which arises from the short saphenous vein just before it enters the popliteal vein in the popliteal fossa. This vein runs up the posterior aspect of the thigh under the deep fascia, which it later pierces to wind subcutaneously internally, fusing with numerous other small subcutaneous tributaries from the popliteal skin and fat to form the large postero-medial trunk It enters the long saphenous vein at varying levels between its upper third to its termination Occasionally it unites at the sapheno-femoral junction or more rarely directly into the femoral vein, just below this point

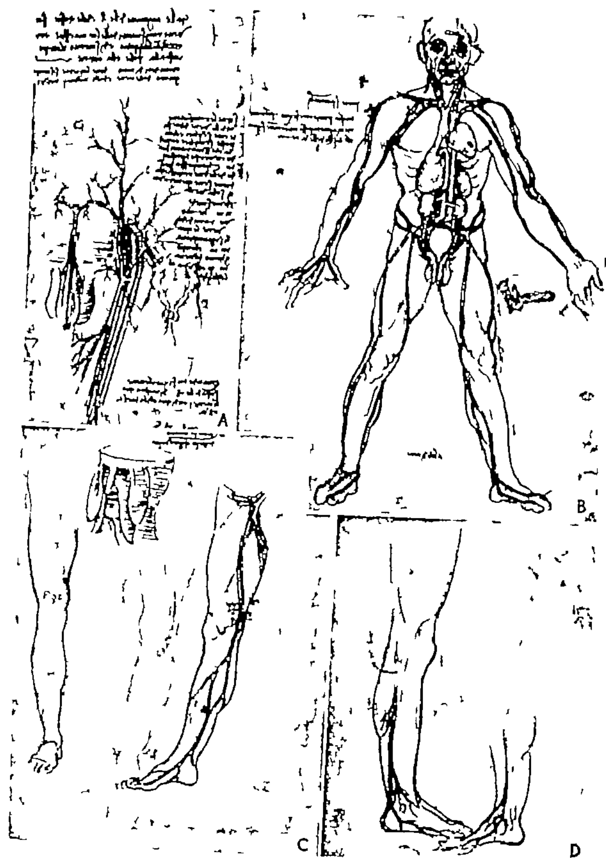


FIG. 22

Drawings of dissections of the veins of the leg by Leonardo da Vinci (1452 1514). A. Dissection of the origin of the great saphenous vein at the fossa ovale B An early drawing, showing the great saphenous vein, its antero-lateral tributary at the groin (compare Fig. 21 p 31) and the constant posterior arch vein arising just below the knee (compare Fig. 20, p. 30). C A drawing of the great saphenous vein in its entirety (compare Fig. 21 p 31) Note again that the posterior arch vein arising from the saphenous just below the knee, is clearly shown. D A drawing of the lower end of the *short* saphenous vein (on the left) and the great saphenous vein (on the right) showing correctly their relationship to the external and internal malleoli

(*These are photog*

At operation it may be difficult to differentiate the postero-medial tributary from the saphenous vein for in the upper thigh both lie on the deep fascia It may also be the main channel of discharge of the short saphenous vein and thus constitutes one of the variations of the small saphenous vein It is an important collateral vein for the return of blood from the lower leg in cases of deep femoral thrombosis and is usually prominent in venograms of the acute condition

The antero-lateral vein (Fig 21) —This vessel drains the antero-external surface of the thigh It courses diagonally upwards from the outer side of the leg, knee and thigh to join the great saphenous vein in its terminal few centimetres Figures 177A and B, pages 210 and 211, illustrate some of the variations in the ending of this vein It lies in the superficial layer of subcutaneous tissue This differentiates it from the internal saphenous vein and the postero-internal tributary, both of which are on the deep fascia When enlarged the antero-lateral vein is visible through the skin and it is often erroneously regarded as the varicose internal saphenous vein

Other tributaries at the saphenous opening (Fig 21) —There are several other tributaries joining the termination of the internal saphenous vein which are surgically important

The superficial and deep external pudic veins —These vessels drain the perineum, upper inner thigh, and external genitalia They run horizontally outwards from these areas to enter the medial aspect of the termination of the great saphenous vein

The superficial external pudic vein lies in the superficial fascia and is constant, it may be duplicated or triplicated

The deep external pudic vein is only present in 30 to 40 per cent. of cases and it enters the long saphenous vein on its postero-internal surface at its union with the femoral vein *within* the fossa ovalis In this deep situation it is easily overlooked during the operation of sapheno-femoral ligation It is occasionally joined here by the postero-medial vein (*see* Figs 175 and 176, pp 208 and 209)

The superficial epigastric vein —This vein passes vertically down from the subcutaneous tissue of the lower and central abdominal wall to enter the end of the long saphenous vein It connects with its fellow on the opposite side across the midline of the lower abdomen, and also with the inguino-axillary vein, thereby forming a communication with the axillary vein These connections constitute bypasses in the event of obstruction or thrombosis of the subclavian, and iliac veins or the inferior vena cava

The superficial circumflex iliac vein —This drains the superficial tissue of the upper and outer aspects of the thigh and the lower and outer quadrant of the abdomen It discharges into the long saphenous vein at its termination often fusing with the superficial epigastric, or the antero-lateral tributary before doing so

A further variation of the superficial external pudic artery is that it occasionally divides, both branches may pass deeply or superficially to the internal saphenous vein, or one may pass over and the other under it (Fig 24)

ANOMALOUS ORIGIN OF THE PROFUNDA ARTERY —A rare but important arterial anomaly is a high origin of the profunda artery It may arise from the femoral artery immediately opposite to or a little above the level of the foramen ovale within the femoral sheath It runs downwards and medially across the femoral vein either immediately *above or below* the sapheno-femoral junction (Fig 25) In this abnormal and unexpected situation the artery may be mistaken for the femoral artery, and is liable to surgical injury We have seen this anomaly four times within a year

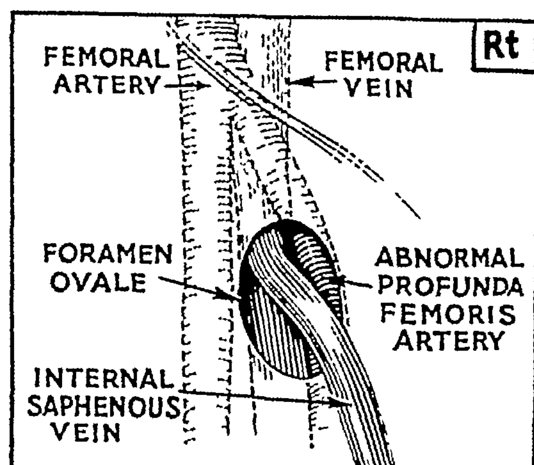


FIG 25
Abnormally high origin of profunda femoris artery crossing the femoral vein and the termination of the internal saphenous vein

SUMMARY —The internal saphenous vein extends from the medial side of the foot to the groin Basically it has two pairs of tributaries, one pair joining it at the knee and the other at the foramen ovale The former consists of the posterior-arch and anterior vein of the leg and the latter of the postero-medial and antero-lateral veins of the thigh They are subcutaneous and when varicosed are visible Varicosity in the internal saphenous system chiefly affects one or more of these long subordinate vessels

The short or external saphenous vein. (*Syn small or lesser saphenous vein*) —Developmentally the external saphenous vein represents the posterior axial vein of the lower limb of the foetus, which terminates in the internal iliac vein, being linked through the sciatic and gluteal veins

The short saphenous vein arises at the outer border of the foot behind the external malleolus from the union of the lateral marginal vein with numerous small veins draining the outer side of the heel It passes upwards between the tendo-Achillis and the posterior edge of the external malleolus (in contrast to the internal saphenous vein, which lies in front of the internal malleolus) Two inches above the tip of the malleolus, the short saphenous vein is just lateral to the tendo-Achillis and from there it ascends on the deep fascia straight up the centre of the calf to the popliteal fossa

At the junction of the tendinous and muscular part of the gastrocnemius muscle, about the middle of the calf, the short saphenous vein enters an intra-fascial compartment in the aponeurotic investment of the gastrocnemius

muscle Thus in the upper half of its course this vein is strongly supported by fascia

The point of entry into the popliteal space is somewhat variable usually occurring at about ½ inch (1 25 cm) below the transverse skin crease behind the knee. Thus its fascial support and deep situation render the termina-

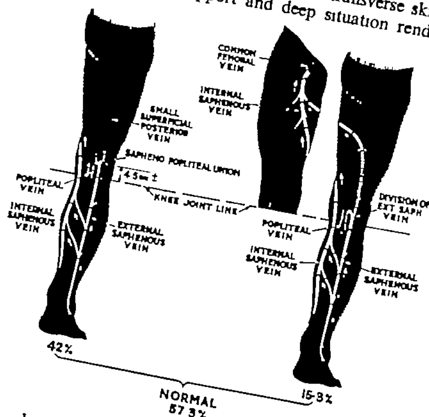


Fig. 26
Kosinski's variations of the external saphenous vein

tion of this vein inconspicuous, even when it may be markedly varicose or dilated About an inch above the transverse skin crease behind the knee it turns deeply to join the popliteal vein, but this level varies considerably from 1 inch below the skin crease to 4 inches above it. Just before it ends, it gives off a vein which ascends subfascially to the inner side of the thigh to become the postero-medial tributary of the internal saphenous vein (Fig. 27) A further tributary may also run directly up the middle of the thigh to the buttock, this is the vestigial remains of the post axial vein (Fig. 26)

Variations in the Termination of the External Saphenous Vein — Kosinski (1926) made over 120 dissections of the external saphenous vein and found that there is considerable variation in the termination of this vein. In general it ends in one of three ways —

1 *Normal* (Fig. 26) In about 57 per cent. it unites with the popliteal vein in the popliteal space a few centimetres above the level of the knee joint.

3B

2 *High* (Fig 27). A high termination occurs in about 33 per cent., and the vessel ends in the centre of the thigh, either in the muscular veins, or into the long saphenous vein in its upper third, *i e*, without entering the popliteal vein

3 *Low* (Fig 28) In about 9 per cent. it joins the deep veins of the calf or the internal saphenous vein in the upper third of the leg

Kosinski further subdivides these variations:—

The normal (57 3 per cent)—The external saphenous vein unites directly with the popliteal vein in 42 per cent of cases In 15 per cent. it divides in the popliteal space into approximately equal branches, one of which joins the popliteal vein and the other ascends under the deep fascia to the centre of the posterior surface of the thigh About the mid-thigh it becomes subcutaneous and turns inwards and upwards to end in the upper third of the internal saphenous vein.

The high termination (33 per cent) —In nearly 14 per cent the vein passes through the popliteal space unchanged and empties entirely into the deep veins of the lower third of the thigh In about 13 per cent the short saphenous vein joins the long saphenous in the upper third of the thigh without previous bifurcation In 6 4 per cent these variations are combined, the small saphenous vein dividing in the popliteal space into equal divisions, one uniting with the deep veins of the lower third of the thigh, the other passing into the great saphenous vein, approximately in the upper third of the limb In about 3 per cent the external saphenous vein also gives small twigs to the popliteal vein, and in 4 5 per cent. there are connections between it and the muscular veins of the thigh

The low termination (9 7 per cent) —In 8 per cent of cases the external saphenous vein joins the internal saphenous vein about knee-joint level In other words the short saphenous vein may be replaced by a large tributary of the long saphenous vein ending at or below knee level In 1 6 per cent of cases it joins the veins in the gastrocnemius muscle in the middle of the calf, constituting in effect a large mid-calf indirect perforating vein (Fig 28)

STRUCTURES ACCOMPANYING THE SHORT SAPHENOUS VEIN.— In its lower third it is accompanied closely on its outer side by the sural nerve, which is of considerable size and must be preserved from injury when operating

TRIBUTARIES —The short saphenous vein drains essentially the lateral aspect of the heel and foot, but there are several communications passing medially in the subcutaneous tissue over the tendo-Achillis to join the venous arches on the inside of the ankle which are connected to the three medial ankle perforating veins Thus it may have some part in draining the inner aspect of the ankle This is clinically important because in this way the effects of incompetence of the external saphenous vein may be exerted on

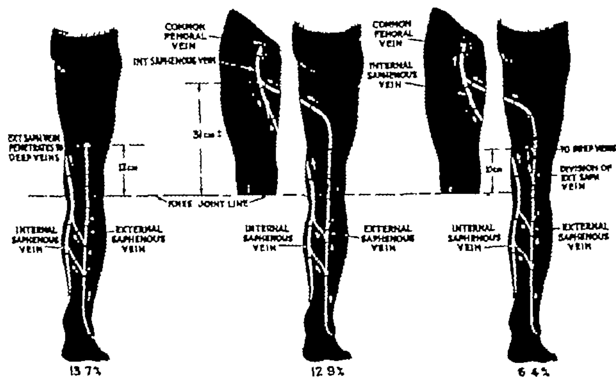


Fig. 27
Kosinski's variations of the external saphenous vein

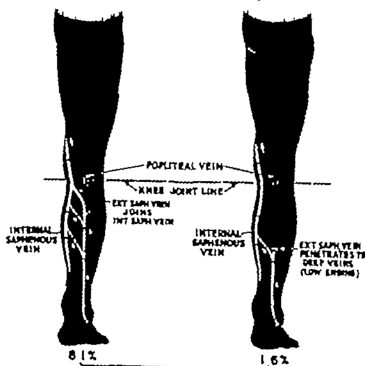
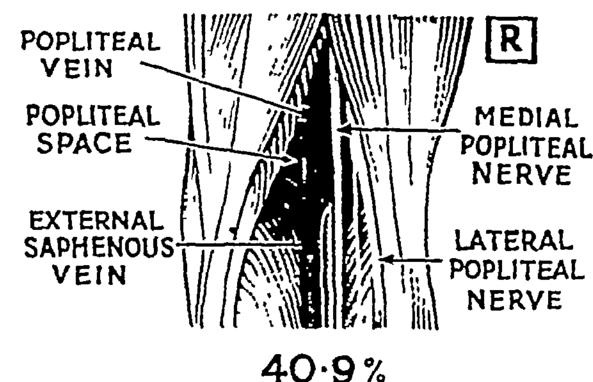


Fig. 28
Kosinski's variations of the external saphenous vein.

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the inner as well as the outer tissues of the ankle At the lower third of the leg it is joined on its outer side by the large and constant lateral ankle perforating vein (*see* pp 42 and 60)



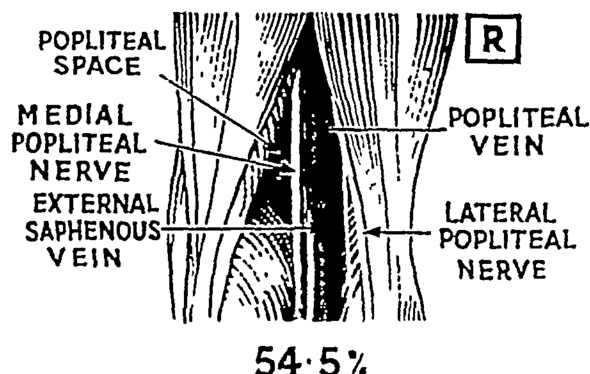


FIG 29

Relationship of external saphenous vein to medial popliteal nerve in the popliteal space

RELATIONSHIP OF THE SHORT SAPHENOUS VEIN AND THE MEDIAL POPLITEAL NERVE—At the termination of the short saphenous vein in the popliteal space the medial popliteal nerve lies external to it in about 40 per cent of cases and internal in 54 per cent (Fig 29). The lateral popliteal nerve is in the outer part of the popliteal space, fairly removed from the vein, and is unlikely to be seen or injured during operation on the vein

THE DEEP VEINS OF THE LOWER LIMB

The principal deep venous components are the anterior and posterior tibial venae comites, the popliteal and femoral veins They receive numerous tributaries from the surrounding muscles, corresponding roughly with the arteries These muscular veins are thin walled and profusely valved and are capable of great dilatation according to the muscular activity of the areas they drain.

The anterior tibial venae comites.—These are the continuation of the dorsalis pedis veins They run upwards between the tibia and fibula lying on the interosseous membrane, closely invested by the anterior tibial group of muscles At the upper fourth of the leg they turn posteriorly over the sharp superior edge of the interosseous membrane close to the neck of the fibula to unite with the trunk formed by the union of the posterior tibial venae comites and the peroneal venae comites to constitute the popliteal vein at the lower border of popliteus muscle.

TRIBUTARIES—During their course they receive numerous muscular tributaries At the lower end of the tibia a large tributary perforates the interosseous membrane to communicate with the origin of the peroneal vein in the posterior compartment of the leg It is accompanied by the anterior perforating branch of the peroneal artery About the middle of the leg a perforating

vein arises and after taking rather a long course communicates with the anterior tributary of the internal saphenous vein which courses over the front of the tibia and anterior tibial muscles (Fig. 30)

The anterior tibial vessels because of their proximity to the neck of the fibula may be involved in injuries to the upper end of the fibula, possibly starting thrombosis in them.

The posterior tibial venae comites.—The medial and lateral plantar veins unite behind the internal malleolus to form the posterior tibial venae comites. These veins run upwards with the posterior tibial artery lying on the tibialis posticus (posterior N T) muscle which separates them from the interosseous membrane and from the anterior tibial venae comites. The posterior tibial vessels lie in the posterior crural compartment and are covered superficially by the soleus and gastrocnemius muscles. They receive numerous veins from these surrounding muscles and perforating veins from the saphenous system. Higher in the leg the large peroneal veins join them to form a single trunk

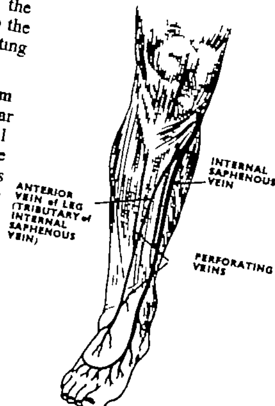
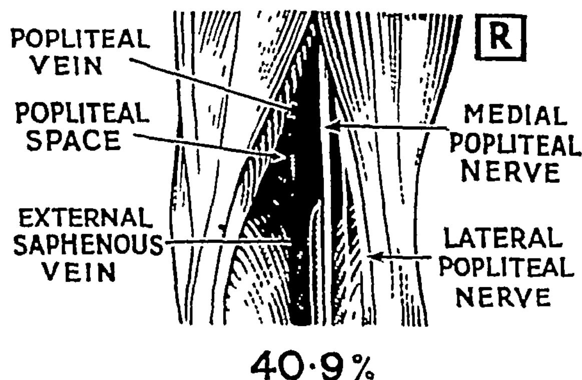


FIG. 30
Anterior perforating veins to the anterior tibial venae comites.

VENOUS DRAINAGE OF SOLEUS AND GASTROCNEMIUS.—Figure 31 shows the anatomy of the venous drainage of the calf muscles in diagrammatic form. Notice that the venous drainage of the soleus and gastrocnemius muscles which constitute the greater bulk of the calf differs in important aspects

Soleus and its venous sinuses.—The soleus muscle has within it a series of large venous sinuses which are devoid of valves. These venous sinuses differ from subject to subject in their size and degree of development. They are of clinical importance as it is in them that "calf" thrombosis commences. They drain by a series of short but lax veins into the posterior tibial and peroneal veins as shown. They are particularly large with considerable slack in the upper part of the calf where they are grouped closely together. During rest they assume a tortuous appearance: this apparent redundancy is occasionally seen on venograms of the region and is sometimes mistakenly called "deep varicose veins" but it is normal during inactivity and is necessary in

the inner as well as the outer tissues of the ankle. At the lower third of the leg it is joined on its outer side by the large and constant lateral ankle perforating vein (*see* pp. 42 and 60)



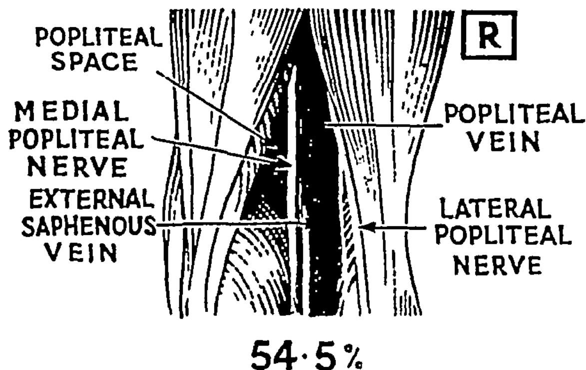


FIG 29

Relationship of external saphenous vein to medial popliteal nerve in the popliteal space

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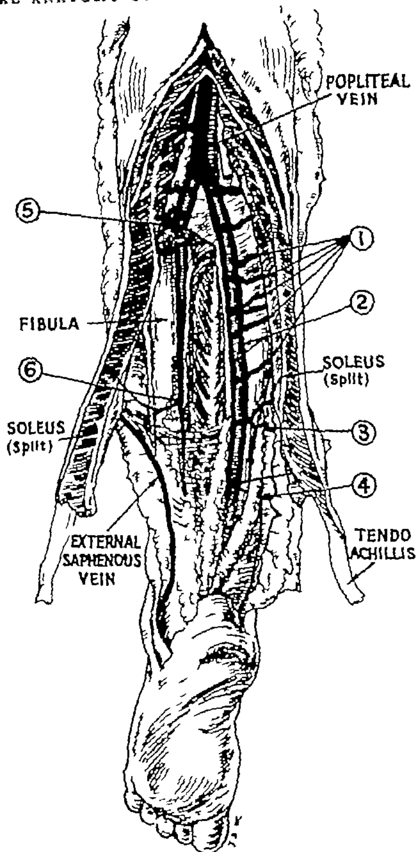


Fig. 32

Dissection of deep veins of posterior compartment of leg.
1 Veins draining soleus (tortuous). 2. Post tibial vena comites. 3 Upper internal perforating vein showing origin. 4 Middle perforating vein. 5 Peroneal vein (goes deep to flexor hallucis—origin at this point). 6. Lateral perforating vein.

order to accommodate the considerable range of movement when the soleus muscle contracts.

The posterior tibial venae comites and soleus muscle—The venous drainage of the lower half of the soleus is particularly interesting and clinically significant as will be seen when we consider the genesis of post-thrombotic ulcers It will be observed in Figure 32 that nearly the whole venous drainage of the lower half of the soleus passes into the posterior tibial veins

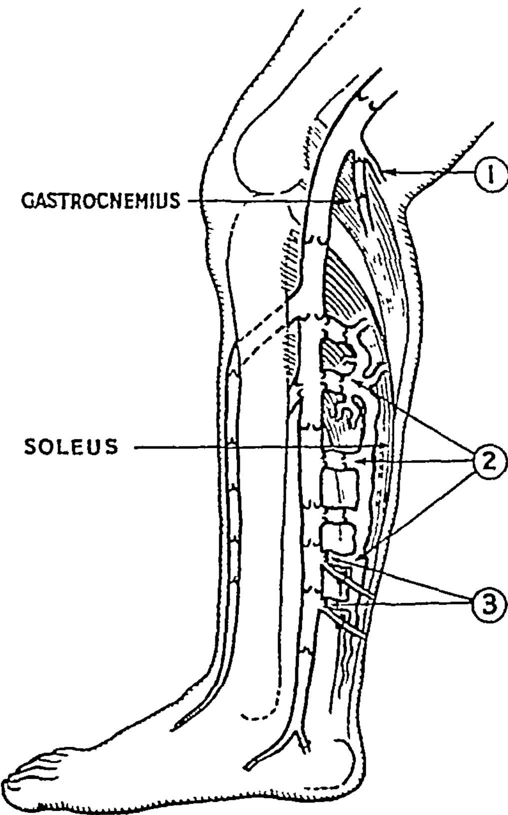


FIG 31

Diagram of Deep Veins of Leg

1 Origin of gastrocnemial veins 2 Venous sinuses in soleus 3 Origin of upper and middle inner ankle perforating veins

In the lower third of the leg the posterior tibial veins receive the two lowest muscular veins from the soleus muscle where they also receive two large perforating veins from the subcutaneous tissues above the internal malleolar region, *i e*, the area of ulceration and induration This union is affected under the deep fascia This interesting anatomical arrangement (Figs 31 and 32) is the key to the appreciation of two facts 1 There is a constant direct venous pathway for the spread of thrombus from the calf muscle sinuses to the posterior tibial veins, which may then propagate outwards along the perforating veins just mentioned, and/or upwards in the posterior tibial veins 2 The reason that the site of election for the cutaneous sequelae of deep thrombosis is so often the inner side of the leg in the malleolar region and not the outer side, is because of involvement of these internal perforating veins in calf sinus and posterior tibial thrombosis, resulting later in the failure of their valves

The peroneal vein and soleus, the lateral ankle perforating vein—The peroneal vein is quite small in the distal third of the leg, and runs deep to the flexor hallucis longus origin from the fibula, and is in close relation to the interosseous membrane In this region, it receives a fairly constant large lateral perforating vein (Fig 32) which as it winds round the fibula receives a tributary from the soleus muscle This is usually the only contribution from the soleus to the peroneal vein in this region

In the upper half of the leg, the peroneal vein emerges from under the flexor hallucis muscle belly to lie in the posterior compartment and here it

plexus of intercommunicating venous channels in which one single dominant channel can scarcely be discerned Reduplication of venous channels in the popliteal fossa and Hunter s canal is thus the rule rather than the exception

A further item is of importance in the region of the adductor canal the plexus of accompanying venae comites is profuse and at this point a constant anastomosis with the profunda system takes place This connection constitutes an important avenue of collateral venous return when the femoral vein

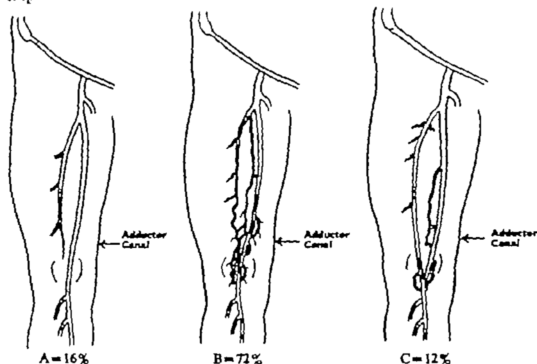


FIG. 34

Variation in the Anatomy of the Femoral and Popliteal Veins.

These drawings present the numerous variations in the anatomy of the femoral and popliteal systems encountered in twenty-six dissections the percentages indicate roughly the distributions of the various types.

The noticeable thing is the variability in the anatomy In group A there is one large main venous trunk, with relatively few small venae comitantes. In group B there is considerable reduplication of the main veins, as well as numerous small venae comitantes. In group C, the profunda vein travels down as a large channel to anastomose with the upper part of the popliteal vein.

is blocked by disease or surgical ligation Finally Figure 34C represents a state found in about 12 per cent. of cases where the lower part of the profunda vein is large and unites directly with the popliteal vein or popliteal venous plexus In such circumstances the profunda vein offers a large alternative pathway of venous return from the leg.

This variation in venous arrangement, and in the number and profusion of available deep collaterals gives some clue to the apparently capricious way in which the symptoms of deep venous obstruction arise and subside in different patients. Thus in group A in which there is only one large deep vein and relatively few deep venae comites, the effect of its occlusion would

receives several large lax tributaries from the lateral aspect of the soleus muscle, which rapidly convert it into a large vein before it unites with the posterior tibial veins in the formation of the popliteal vein

Gastrocnemius muscle—Each belly of the gastrocnemius muscle is drained by a single large vein which enters the popliteal vein in the lower part of the popliteal fossa (Fig 31) They are easily picked out and are accompanied by an artery and a nerve

These veins are often seen on venograms of the region When the valves of the popliteal and femoral veins are destroyed by the process of deep thrombosis and recanalisation, these veins are subjected to an increased venous pressure and sometimes dilate and become tortuous and varicose, constituting one type of "true" deep varicose veins (Fig 33)



FIG 33
Varicose gastrocnemial veins in a patient who had an incompetent re-canalised deep vein (proved by operation)

THE DEEP FASCIA OF THE LEG, CALF-MUSCLE PUMP—Before leaving the anatomy of this region an essential and unique point must be mentioned The deep fascia of the leg invests the whole of the calf muscles tightly, especially in its lower third where it becomes a strong, tough aponeurosis which embraces soleus muscle very firmly So intimate is this enclosure that when the fascia is cut during dissection, soleus muscle immediately bulges through the incision in a striking fashion This arrangement of a large muscle tightly invested by a strong unyielding fibrous fascia constitutes an extremely efficient pump mechanism, as during calf muscle contractions, because of the arrangement of the valves, its blood is expressed forcibly towards the heart

The popliteal and femoral veins.—The anatomy of the popliteal and femoral veins is shown in Figure 34. A represents the basic pattern, but it is unusual for the popliteal and femoral veins to be represented by one single large trunk, as is depicted in most anatomy books; B represents a commoner state of affairs where there is a main channel, with numerous venae comites, which are usually closely applied to the accompanying artery and intercommunicate in a plexiform manner Thus the popliteal and femoral veins show considerable variation from a fairly isolated single large channel (as is usual in textbooks) to a

plexus of intercommunicating venous channels in which one single dominant channel can scarcely be discerned Reduplication of venous channels in the popliteal fossa and Hunter s canal is thus the rule rather than the exception.

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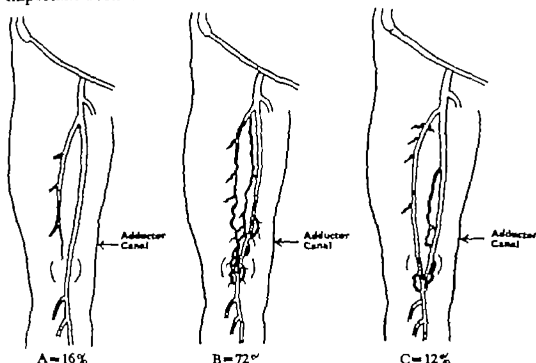


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be more severe and long standing than in groups B and C where there is a rich plexus of deep veins and many large and small alternative channels to form the collateral circulation

The popliteal vein lies deeply in the popliteal fossa but is superficial to the popliteal artery which it crosses from its medial to its lateral aspect as it runs upwards The tibial nerve is superficial to both and is found just underneath the popliteal fascia in the fat adjacent to the short saphenous vein

In Hunter's canal the superficial femoral vein lies deep to the femoral artery, but as it ascends into Scarpa's triangle it crosses behind the artery to gain its medial aspect. About two inches below the inguinal (Poupart's) ligament, the large profunda femoris vein (deep femoral vein) unites with it posteriorly to form the common femoral vein which ascends medially to the artery, both being enveloped in the common femoral sheath. It passes beneath the inguinal ligament to become the external iliac vein

The profunda femoris vein.—*The site of union of the profunda vein* (deep femoral vein) with the femoral vein (superficial femoral vein) to form the common femoral *is rather inconstant* This junction may take place anywhere from just below the inguinal ligament to a quarter of the way down the thigh. Occasionally the profunda vein is reduplicated The most *important tributaries of the profunda vein* are the medial and lateral femoral circumflex veins

In the event of obstruction to the femoral vein, the profunda is an effective collateral vein in the drainage of the leg and thigh Further, by its connections with the obturator, sciatic, and gluteal veins, and thence to the internal iliac veins, a considerable alternative pathway is available from the lower limb to the inferior venae cava

THE PELVIC VEINS

Familiarity with the anatomy of pelvic veins reveals the collateral venous channels available in deep thrombosis or obstruction of the *main* iliac or femoral veins (Fig 35).

The external iliac vein.—This vein courses from the inguinal ligament inwards and upwards along the brim of the true pelvis to the sacro-iliac articulation where it is joined medially by the internal iliac vein emerging from the true pelvis

Tributaries—The external iliac vein receives veins from the muscles of the anterior abdominal wall and iliacus muscles, these connect it with the superficial epigastric and circumflex iliac veins (tributaries of the termination of the internal saphenous vein) The main tributaries of the external iliac vein are the *deep circumflex iliac vein, the small pubic vein,* and the *inferior (or deep) epigastric vein* These last two anastomose with their fellows of the

opposite side and also with the superficial external pudic veins, also tributaries of the internal saphenous vein

The internal iliac vein.—This large vein is formed in the floor of the true pelvic cavity by the union of the gluteal sciatic internal pudendal and obturator veins, which originate in the buttock thigh and perineum In the

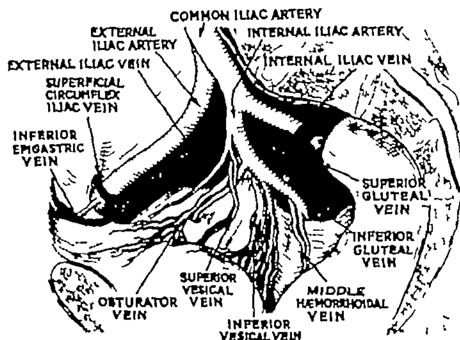


FIG. 35
Internal iliac vein and its tributaries.

pelvis it is joined by the lateral sacral veins and the middle rectal veins from behind and by numerous visceral veins draining the bladder and uterus. Most of these tributaries anastomose freely across the midline with the other side The resulting large trunk runs upwards on the lateral wall of the pelvis, lying behind the internal iliac artery At the brim of the pelvis it joins the external iliac vein thus forming the common iliac vein Valves are not described in the trunk of the internal iliac vein but are said to be present in its peripheral tributaries. In a few post mortems we have examined the internal iliac veins but we saw no valves Quain s Anatomy (1892) states it has no valves

The internal pudendal veins and the gluteal veins are significant in considering the aetiology of some cases of varicose veins, as their cutaneous tributaries frequently become varicose in cases of obstruction of the common or internal iliac veins by pregnancy a pelvic tumour and in thrombotic occlusion of these veins Varices in connection with the gluteal veins emerge from under the gluteal fold, and those of the internal pudendal veins occur in the labia and perineum

Barrow (1949) recalls Barcroft s (1932) work in rabbits which showed that in the first three months of pregnancy the internal iliac vein dilates to

carry over thirty times its normal volume of blood This hints at the potential capacity of the internal iliac vein in the drainage of the lower limb in the event of obstruction to the femoral and external iliac veins (Fig 36)



FIG 36
Intra-osseous per trochanteric venogram of internal iliac vein illustrating (*a*) an obstructed common iliac vein, (*b*) the anastomosis with the opposite side, and (*c*) the large volume capacity of the internal iliac vein (*By courtesy of the British Journal of Radiology*)

The common iliac vein.—This vein is a short wide trunk which passes upwards from the sacro-iliac joint to end on the right side of the fifth lumbar vertebra by uniting with that of the other side at an acute angle to form the inferior vena cava Note that this point is one whole vertebra lower than the bifurcation of the aorta Also that the left common iliac vein is crossed by the origin of the right common iliac artery, and if this vessel becomes aneurysmal or arteriosclerotic it may obstruct the left common iliac vein Each common iliac vein receives the ilio-lumbar vein which is its main tributary and this constitutes an invaluable anastomotic channel in the event of obstruction of the inferior vena cava or ligation of the common iliac veins

THE VALVES

The valves of the deep veins.—The valves of the leg veins are profuse and of great importance in the pump mechanism whereby blood is returned to the heart against gravity in the upright position In the venous sinuses in the soleus muscle there are no valves, but in all the muscular veins draining both the soleus and gastrocnemius muscles into the deep veins, valves are numerous The posterior tibial and peroneal veins and the anterior tibial veins are profusely valved, the valves being situated about every inch or so In addition, all the perforating veins in the lower part of the calf, and all veins connecting the deep with the superficial veins in all parts of the lower limb are so valved that normally blood can only pass from the superficial to the deep veins, and reflux outwards towards the skin is prevented

The arrangement of valves in the large deep venous trunks, the popliteal, femoral, common femoral and iliac veins, is variable but a knowledge of this is important in considering the aetiology of both superficial varicose veins, and deep venous incompetence This subject has been studied in recent years by Eger and Casper (1943), Powell and Lynn (1951), Basmajian (1952) and Cockett (1953)

In a series of twenty-six dissections of the venous system of the lower limb from the inguinal ligament to popliteal fossa, the veins were opened up

and the number and site of the valves were studied For the purpose of mapping out the valves, the veins were divided into four lengths or segments shown in Figure 37 There was considerable variation in segment (*b*) as the level of origin of the profunda vein varied considerably

The findings were as follows (Fig. 37) —

Segment A — Six out of twenty-two cases were valveless The rest (*i.e* sixteen) had one in this segment.

Segment B — No cases had a valve between the internal saphenous vein ending and the profunda origin

Segment C — Eight cases had four or more valves

Twelve cases had three valves

Three cases had two valves.

One case had one valve.

Segment D — Four cases had three or more valves

Eight cases had two valves

Eleven cases had one valve.

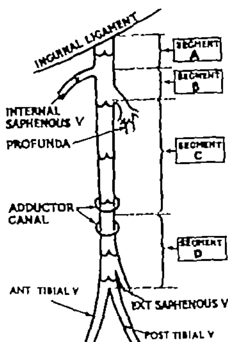


FIG. 37

Diagram of the arrangement of valves of the Femoral and Popliteal Veins.

A. The common femoral vein above the origin of the long saphenous vein. B The common femoral vein between the origin of the long saphenous and the profunda veins C. The femoral vein (or superficial femoral) between the origin of the profunda vein and the adductor ring, where the vein goes through the tendon of adductor magnus to reach the popliteal fossa. D The popliteal vein.

In one case, only two valves were present in the whole vein from the inguinal ligament to the popliteal fossa. The greatest number of valves seen in the entire length was nine the average number was five. All the tributaries and particularly the muscular veins were profusely valved All the valves were arranged in such a way as to allow the flow of blood *into* the deep vein and upwards (*i e.*, a centripetal stream) The most constant valve was that below the point where the profunda femoris vein joined the femoral vein to become the common femoral vein The valve distribution is well seen in Figure 38 which is a photograph of a dissection The highest femoral valve is placed at the point where the profunda joins it, but the first profunda valve is an inch or more down the vein This position of the valve explains the reason why in many descending or retrograde phlebograms the dye tends to flow into and fill the profunda system if the highest femoral valve is incompetent its significance has been noted also by Boyd *et al* (1953)

4

The other sites where valves were *constantly* present were at the level of the adductor canal and in the mid-femoral region.

Many of these valves were tested for competence by injecting saline retrogradely down the vein All effectively prevented the retrograde flow and were obviously sound

We were unable to correlate the number of valves with the age of the patient in this small series, thus agreeing with the findings of Powell and Lynn (1951) based on twenty-seven dissections.

Thus again the emphasis is on the variations of normal anatomy According to these results, any number from two up to nine valves may be regarded as normal. Although complete absence of valves in the femoral and popliteal vein was not found in these dissections, there is some venographic evidence that rarely such cases occur (that is to say congenital absence of the valves as opposed to post-thrombotic destruction) Even in these cases all the valves in the muscular veins and in the deep veins of the calf appear to be present so that it is doubtful if even this congenital anomaly would lead to very striking symptoms A knowledge of the variation of anatomy of these valves is important in the interpretation of venographic appearances

The classic work done by Eger and Casper (1943) on the valves of the external iliac and common femoral vein is illuminating, and reveals the potentiality of internal saphenous varicosis in nearly 40 per cent of people. These authors dissected out the valves of the external iliac and common femoral veins proximal to the sapheno-femoral junction in thirty-eight cadavers Their results were as follows:—

1. No vein contained more than one valve; thus in all persons only one barrier protects the internal saphenous vein from abdomino-thoracic pressures.

2. Bilateral absence of valves	3 =	7 9 per cent
3 Unilateral absence of valves (Rt 4, 10 4 per cent Lt. 7, 18·5 per cent)	11 =	28·9 per cent.
4 Total absence on one or both sides	14 =	36·8 per cent

Rt ext iliac vein valveless but one valve in common femoral vein	21 =	55·2 per cent.
Lt ext iliac vein valveless but one valve in common femoral vein	20 =	52 6 per cent
Rt femoral vein valveless but ext. iliac vein one valve	4 =	10·4 per cent.
Lt. femoral vein valveless but ext. iliac vein one valve.	2 =	5·2 per cent.

Recalling that the common iliac veins and inferior vena cava are valveless this study reveals that:—

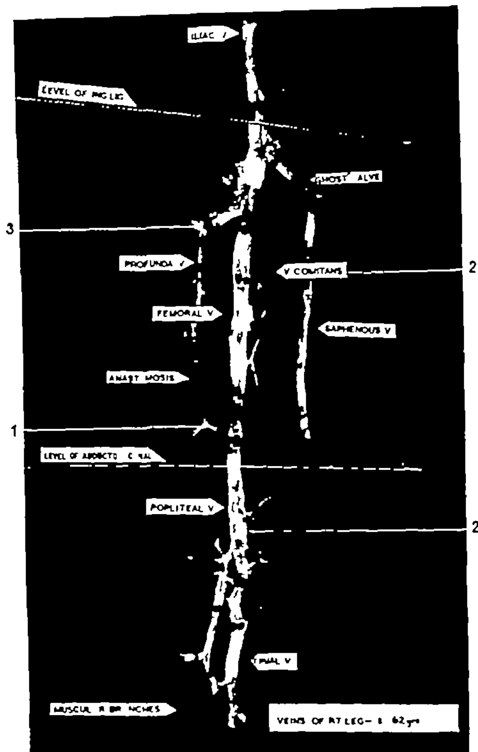


FIG. 38

Dissection of Femoral and Popliteal Veins to show Valves.

This is a photograph of a dissection of the femoral and popliteal veins and their tributaries. The specimen was removed *in toto* from a post mortem body dissected free, opened and pinned out on a board The valve cusps were filled with a small plug of cotton wool soaked in methylene blue, to make them show up on a photograph.

Note (1) The anastomosis of the profunda vein with the main femoral vein taking place by small branches at the level of the adductor canal. (This is a constant finding.) (2) The venae comitantes in both the femoral and the popliteal regions. (3) The situation of the first profunda valve.

1. Normally the thoraco-abdominal pressures on the veins of the lower limb are resisted by a single valve in the external iliac or common femoral veins

2 The valve in the external iliac or femoral vein is absent bilaterally in 7·9 per cent. and unilaterally in 28·9 per cent thus in these types (totalling 36 8 per cent) thoraco-abdominal pressures are exerted directly on the highest valve of the internal saphenous vein with the possible ultimate development of varicosities

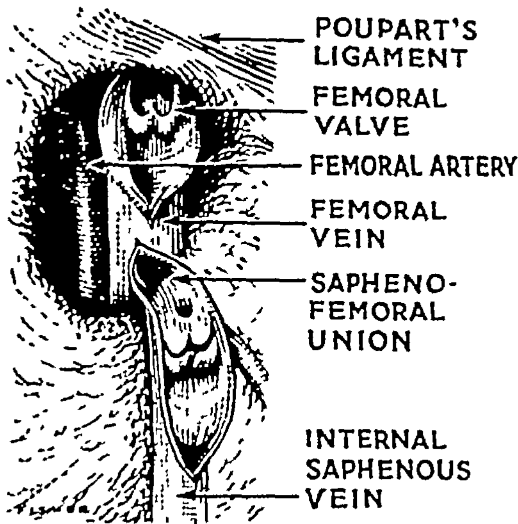


FIG 39
Valves in femoral and internal saphenous veins

3 The deep veins of the lower limbs in these 36 8 per cent of subjects are protected by the valves below the bifurcation of the common femoral veins into the superficial and deep femoral veins (profunda veins)

The valves of the superficial veins (Fig 39) —For practical purposes those of the long and short saphenous veins only are significant in varicosis

From our study of the lumens of varicose saphenous trunks removed at operation we have divided the valves into two types—major and ordinary.

Major valves consist of strong white cusps and firm thickened attachments to the vein wall, with obvious sinuses above them They are conspicuous to the naked eye on opening the vein and are usually at the end of the venous trunks We have occasionally seen one in the middle of the internal saphenous vein below the point of entry of the posterior arch and anterior veins of the leg, *i e*, at the level of the knee.

Ordinary valves are delicate structures Their cusps are almost transparent; there is little or no change in the vein wall either in consistency or size of lumen where they are attached. They are not easily seen, but when a trickle of water is run on them centrifugally, the cusps float outwards, the water stream eddies and they become visible

THE VALVES OF THE INTERNAL SAPHENOUS VEINS —These are variously described by the anatomy books The consensus of opinion is that there are one or occasionally two major valves in the terminal 2 - 3 cm. and thereafter 10 - 20 lesser or ordinary valves to the ankle (*Quain's Anatomy*, 1892) *Gray's Anatomy* (1954) remarks that there are more in the leg than in the thigh Whilst Beesley and Johnston (1939) state that there are six to eight valves below the knee Our inspections of stripped varicose internal saphenous veins confirms the increased frequency below the knee

In a personal communication P Warren, F R C.S., states that in his studies of apparently normal internal saphenous veins from the knee to the groin the number of valves averaged 4 5 with a variation of three to seven

THE VALVES OF THE SHORT SAPHENOUS VEIN —The short saphenous vein is rather more than half the length of the long saphenous trunk but it is much more closely valved It has a major valve at its termination (personal observation) and has six to twelve ordinary valves in its trunk to ankle (*Quain s Anatomy*) This follows the general rule regarding the valves of veins that the more peripheral the vessel is the more frequently is it valved

The findings in varicose saphenous trunks will be touched on in Chapter VIII Our observations of the varicose long and short saphenous veins removed at operation have shown the outstanding strength of their terminal valve They are occasionally duplicated Further the valves in these defective veins are fewer than the text-books state, especially in the internal saphenous vein

PERFORATING OR COMMUNICATING VEINS

The perforating, or communicating veins normally carry blood from the superficial to the deep veins They are of paramount importance in connection with varicose veins and even more so with reference to ulcers of the lower third of the leg Therefore they merit special consideration. In health they are so valved that they only permit blood to flow in one direction, *i.e* from the superficial to the deep veins.

DIRECT AND INDIRECT COMMUNICATING VEINS —Le Dentu (1867) originally described perforating veins as direct or indirect. *Perforating veins are direct* when they pass straight from the superficial vein to the main deep veins or venae comites (*i e* the peroneal posterior tibial anterior tibial popliteal or femoral) *They are indirect* when they pass from a superficial vein to a muscular vein within one of the large muscle bellies of the calf or thigh and thence a further vessel connects with the main deep vein. According to Gay (1868) perforating veins usually start from subcutaneous veins of secondary size *i e* tributaries of the saphenous trunks, and not from the main vessels This statement is in accord with our own experience. *Whilst the indirect perforating veins are small and numerous irregularly distributed throughout the muscular part of the limb the direct communicating veins are few fairly large in size and relatively constant in their anatomical position*

THE CHIEF DIRECT PERFORATING VEINS —The chief direct perforating veins are really the ends of the internal and external saphenous veins Their terminal portions sometimes referred to as "crooks," are best considered as perforating or communicating vessels between the superficial and deep systems which during the course of development have assumed importance in the normal superficial venous return from the leg.



FIG 40
Normal femoral vein showing communicating vein at level of lower third of thigh

FIG 41
Venogram showing the same communicating vein as in Figure 40 when its valves became incompetent



FIG 41

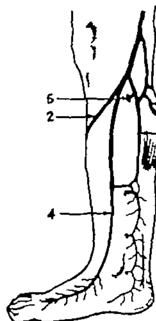
They are, however, only part of a series of direct perforating veins, incompetence in any of which, by allowing a flow from the deep to the superficial veins will produce its special deleterious effect on the adjacent superficial circulation and tissues

Each perforating vein above the ankle is valved at its union with its deep vein and also close to its origin before it perforates the deep fascia.

PERFORATING VEINS IN RELATION TO THE INTERNAL SAPHENOUS SYSTEM.

In the thigh—In the thigh there is a constant rather long perforating vein which begins in the internal saphenous vein or more usually one of its

tributaries about the middle to lower third of the thigh and ends in the segment of femoral vein below the deep femoral valve in Hunter's Canal. This is shown in Figure 40 which is the normal size and position of the vein Figure 41 shows what may occur when the valves in this perforating vein become incompetent. This vein is occasionally duplicated



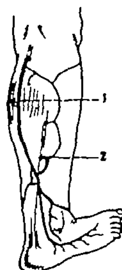


FIG 42 FIG. 43

FIG. 42—*The long saphenous vein and the internal ankle perforating veins*

1 The connection with the short saphenous vein.
2. A tributary from the anterior surface of the leg.
3 The posterior arch tributary which also links the three internal ankle perforating veins.
4 The internal saphenous vein.
5 A constant direct communicating vein.

FIG. 43—*The usual arrangement of the external ankle perforating veins* There is usually one large constant perforating vein (2) in the position shown 4 to 7 inches above the tip of external malleolus at the outer border of the tendo-Achillis. It usually connects with the external saphenous vein (1)

In the leg—Just below knee level a vein usually runs close to the posterior border of the tibia from the internal saphenous or its large tributary (posterior arch) to the posterior tibial veins. This is fairly constant and is shown in Figure 42(5)

In the lower half of the leg there are direct perforating veins of great clinical significance These are known as the internal and external ankle perforating veins (Figs 42 46)

The internal ankle perforating veins—These three veins collect the venous drainage of the lower and inner third of the leg; they penetrate the deep fascia and empty directly into the lower part of the posterior tibial

venae comites They are short and distinctive vessels, and there is some variation in their relative size from case to case.

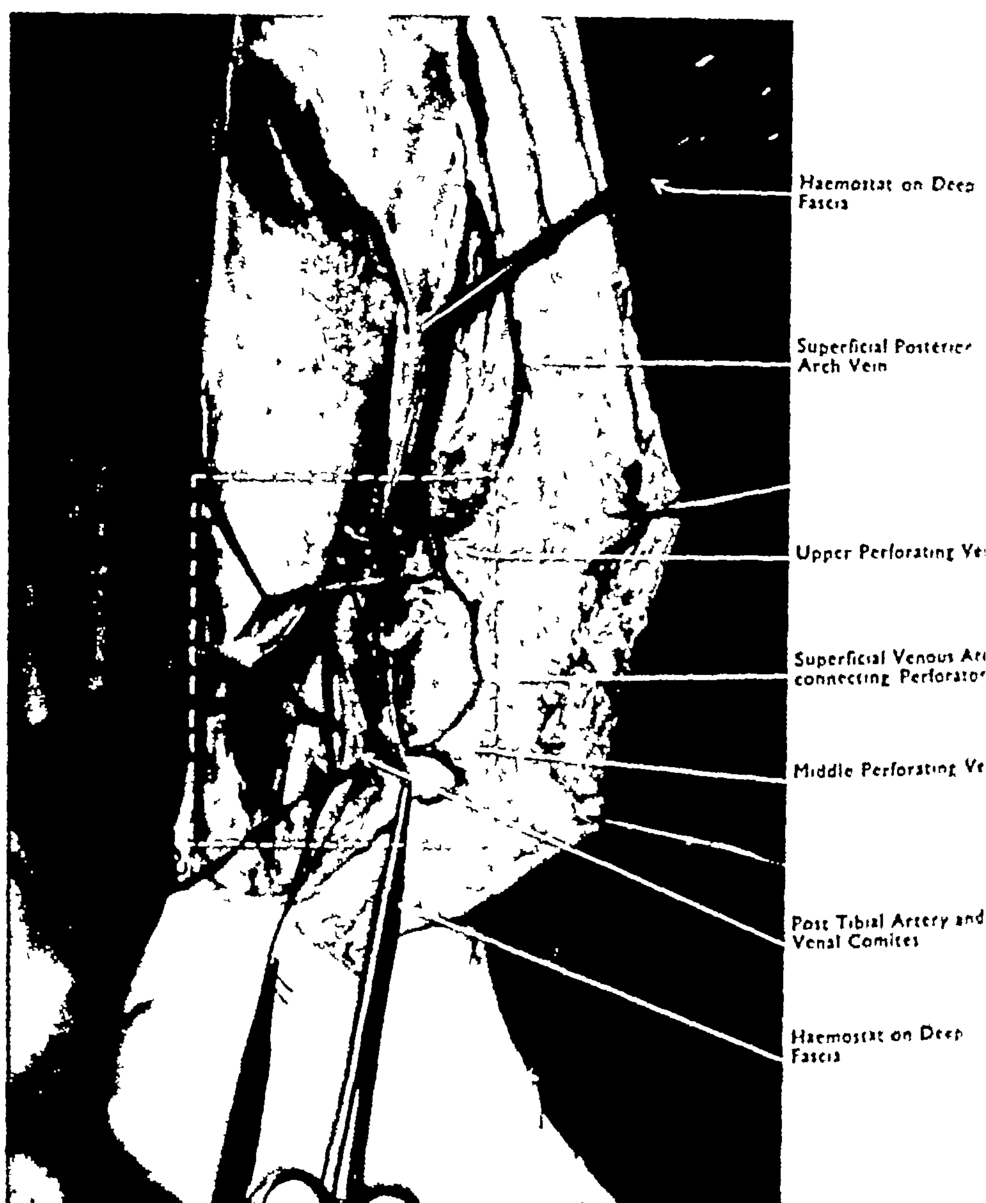


FIG 44

Photograph of the dissection of an amputated leg, prepared by injecting black neoprene into the veins showing the detailed anatomy of the upper two ankle perforating veins on the inner side of the lower leg The illustration shows the inner aspect of the lower leg dissected from behind The upper and middle perforating veins are shown labelled The fine venous arches connecting the perforators in the subcutaneous tissue are seen

The dotted square represents the "close up view," Figure 45

The upper one of the three is the most constant in its situation at about the junction of the lower and middle thirds of the leg at the bony margin of

the tibia (Figs 44 46) It constantly communicates with the long saphenous vein by a small tributary vein but seldom directly Occasionally it connects

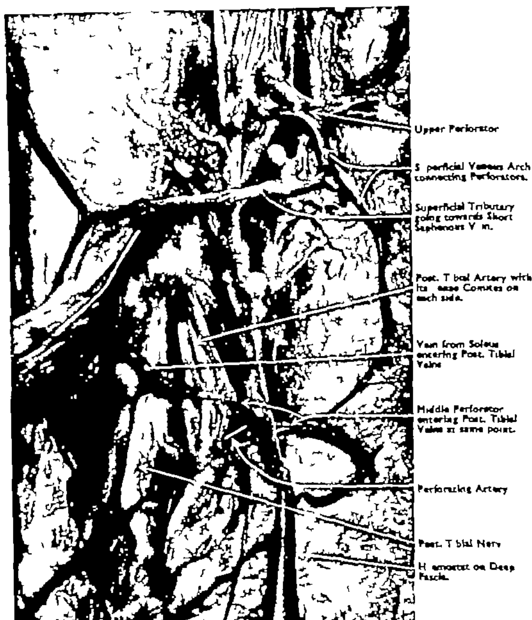


FIG. 45

This illustration shows the close-up (enclosed by the dotted lines in Figure 44) of the region of the middle perforator The artery forceps are holding up the deep fascia, and the vein is seen perforating it to enter the posterior tibial venae comites, and notice particularly how the vein from soleus joins in at the same point. This arrangement is also evident in the upper perforator (Fig. 46) The small perforating artery is well seen.

mainly with the long saphenous vein and merely gives a small tributary to the venous arch connecting it with the other two perforating veins (Fig 47)

venae comites They are short and distinctive vessels, and there is some variation in their relative size from case to case

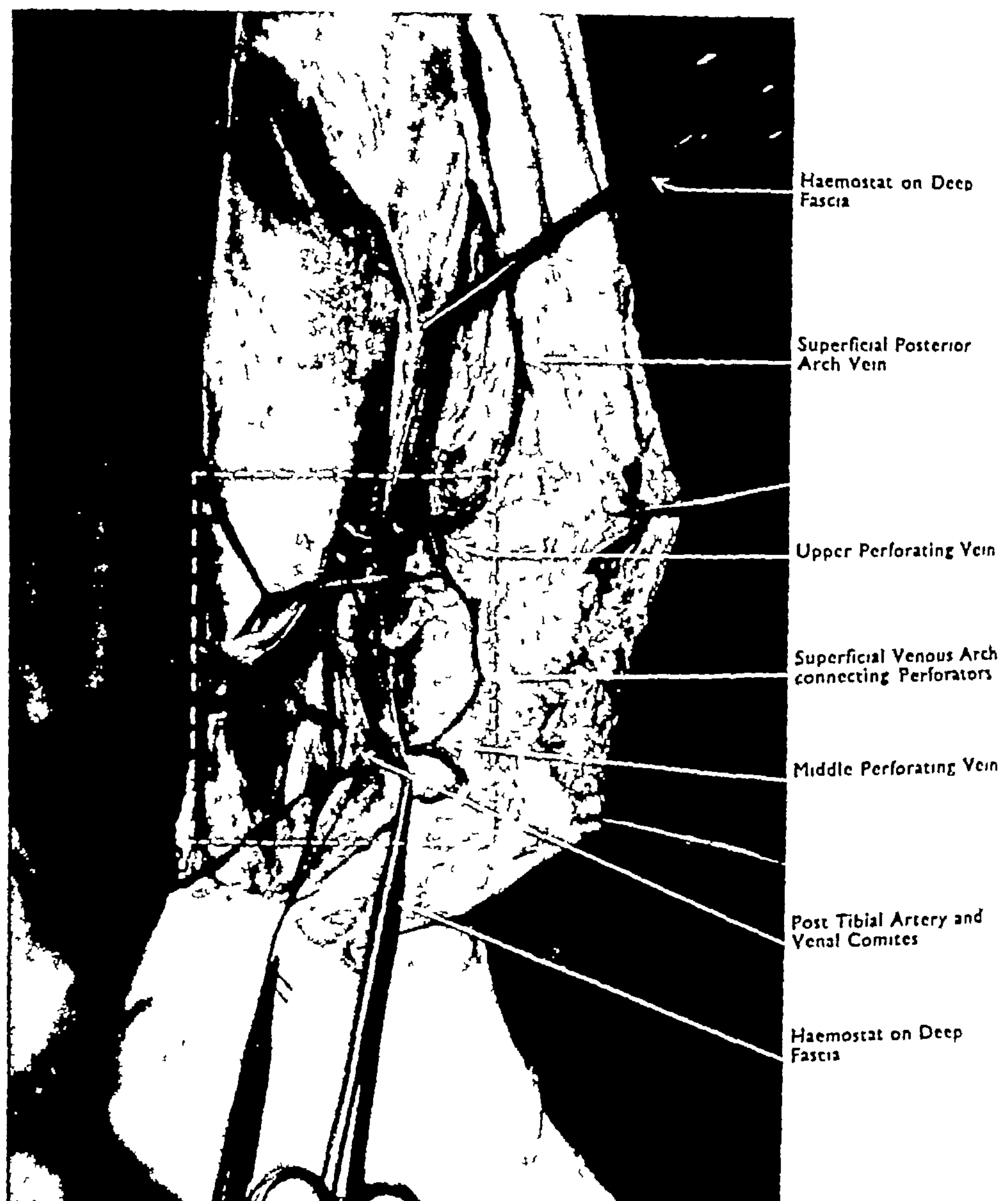


FIG 44

Photograph of the dissection of an amputated leg prepared by injecting black neoprene into the veins showing the detailed anatomy of the upper two ankle perforating veins on the inner side of the lower leg The illustration shows the inner aspect of the lower leg dissected from behind The upper and middle perforating veins are shown labelled The fine venous arches connecting the perforators in the subcutaneous tissue are seen

The dotted square represents the "close up view," Figure 45

The upper one of the three is the most constant in its situation at about the junction of the lower and middle thirds of the leg at the bony margin of

the tibia (Figs 44 46) It constantly *communicates* with the long saphenous vein by a small tributary vein, but seldom directly Occasionally it connects

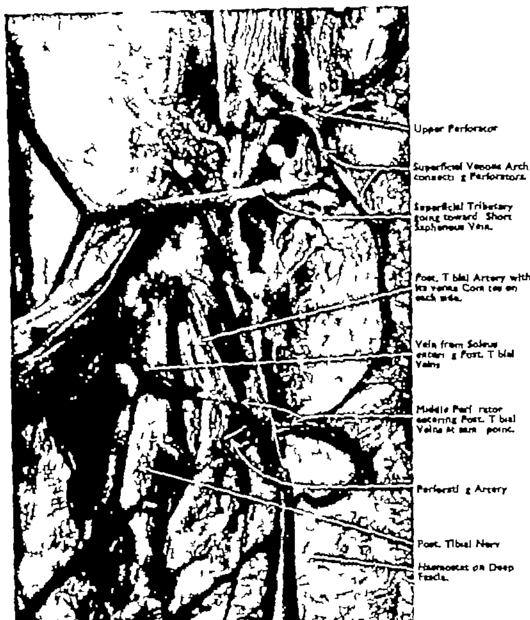


Fig. 45

This illustration shows the close-up (enclosed by the dotted lines in Figure 44) of the region of the middle perforator The artery forceps are holding up the deep fascia, and the vein is seen perforating it to enter the posterior tibial venae comites, and notice particularly how the vein from soleus joins in at the same point. This arrangement is also evident in the upper perforator (Fig. 46) The small *perforating* artery is well seen.

mainly with the long saphenous vein and merely gives a small tributary to the venous arch connecting it *with the* other two perforating *veins* (Fig. 47)

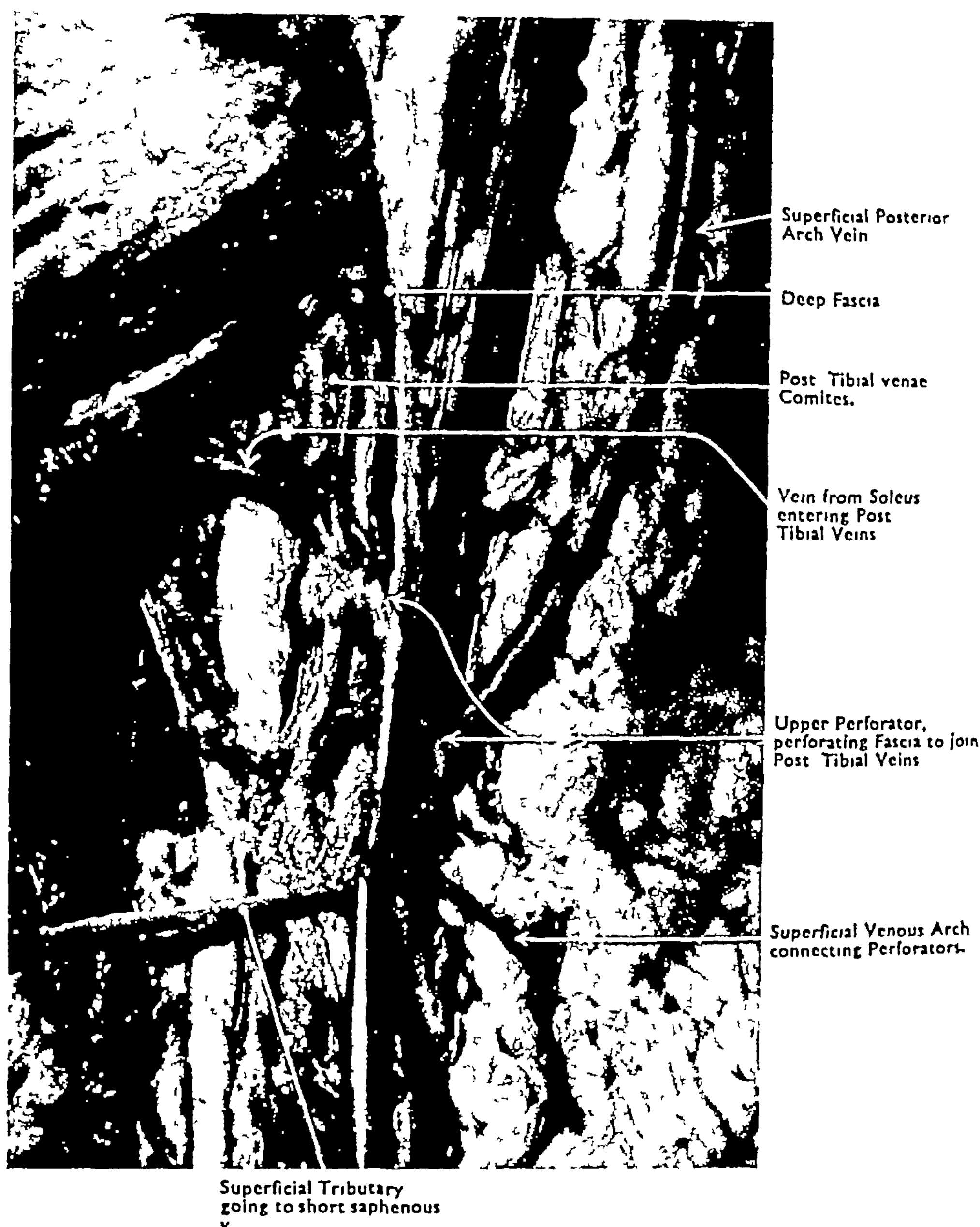


FIG 46

Photograph of the further dissection of the same amputated leg, showing the detailed anatomy of the upper ankle perforating vein on the inner side of the lower leg, dissected to show its entry through the deep fascia into the posterior tibial venae comites

The middle perforator is fairly constant in position usually about four fingers breadth above the tip of the internal malleolus and ½ inch to 1 inch posterior to the bony margin of the tibia

The lowest perforator is just behind and below the internal malleolus situated over the surface marking of the posterior tibial artery and venae comites and it is usually small in comparison with the other two

There appears to be some reciprocity in size between the middle and upper of these veins Thus when the upper is large and well developed the middle tends to be small and vice versa (this is illustrated in Figures 47 and 48 In one of the dissections the upper perforating vein was much the larger of the two)

It can thus be appreciated that in the erect position the essential venous drainage of what is known clinically as the ulcer bearing area is taken directly into the deep veins and not into the saphenous system On the other hand the effects of

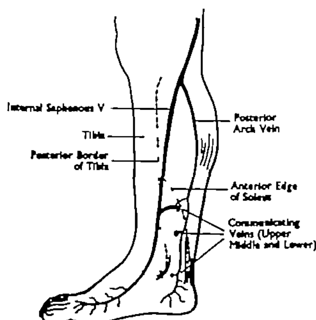


FIG. 47

Variation in the anatomy of the upper internal ankle perforating vein.



FIG. 48

Variations in the anatomy of the upper (large) and middle (small) ankle perforating veins.

venous incompetence in the great or small saphenous systems can readily reach this area via their connections with the venous arches linking these perforating veins (Figs. 42 43) It is into these thin-walled venous arches and the perforators that numerous small delicate vessels empty blood from the subcutaneous tissues of the ankle region.

The relation of the internal ankle perforating veins to the venous drainage of the soleus—In this connection an interesting and important anatomical point must be described A study should be made of Figures 44 - 46, which are photographs of detailed dissections of the upper and middle perforating veins on the inner side of the leg These perforating veins enter the posterior tibial venae comites at the point where one of the large veins draining the soleus muscle also joins At this place too there is usually a large cross communication between the two venae comites causing a venous pool here In fact, there is here a direct anatomical pathway for a thrombus spreading down the muscular veins from the soleus muscle to enter not only the posterior tibial veins, but also the perforating veins The organisation and recanalisation of such a thrombus will involve destruction of the valves of the obstructed vessels including those of the incompetent perforating vein in this situation. This actual occurrence in the acute state (*i e*, spread of thrombus) has been seen by one of us at a post mortem and we believe that this is probably the mechanism whereby the valves of the upper two perforating veins are destroyed The third and lowest perforating vein behind the malleolus has no such arrangement It is not in connection with any muscle, and is simply a direct small size tributary of the posterior tibial venae comites Thus, there is no similar mechanism for the destruction of its valve This is in accordance with our findings at operation. This third, lowest vein is usually small and we have seldom found it demonstrably incompetent; it probably plays little essential part in the aetiology of the ulcer syndrome.

This anatomical arrangement of the upper, and middle internal ankle perforators was noted and commented upon by Gay (1868) He made the remark that at these points there appeared to be an alternative venous pathway direct from the soleus muscle to the superficial vein, which could be used if the deep veins were blocked

Direct perforating veins related to the short saphenous system—There is one large constant external perforating vein whose origin has already been referred to (pp. 40 and 42 and Fig 43) in the position shown (The common arrangement is shown in Figure 43) This vein joins the small saphenous vein or a tributary of it, after a characteristic looped course round the fibula at the junction of the lower and middle third of the calf on the lateral side This vein is called the lateral, or external ankle perforating vein (Fig 49) ; it is a direct perforating vein As it penetrates the deep fascia it receives a tributary from the lower part of the soleus muscle and then winds round the fibula to join the peroneal vein This vessel therefore, is significant from the point of view of ulceration of the lower third of the leg, as its valves can be destroyed by a thrombus spreading along it from the vein from the soleus muscle

More rarely there may be an exactly similar but much smaller perforator about two inches above this one (Fig 43)

Direct perforating veins on the anterior aspect of the leg—About the middle of the leg there is a perforating vein which arises in the anterior vein of the leg (a tributary of the long saphenous vein) (Fig. 30) It perforates the deep fascia and pursues a long oblique course upwards to end in the anterior tibial venae comites It is not usually of great size nor of clinical significance

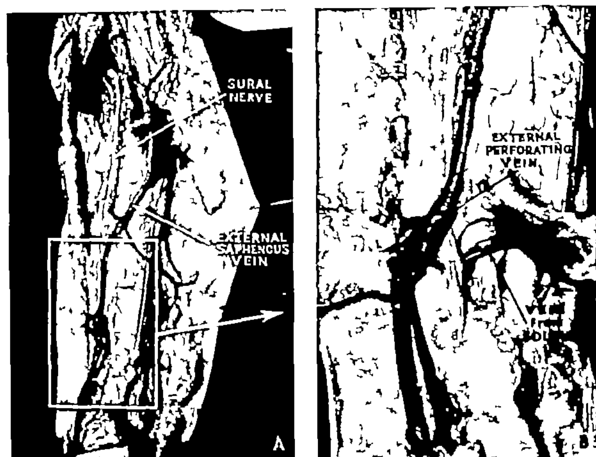


FIG. 49

Dissection of the External Ankle Perforating Vein.

Photographs of the dissection of the posterior aspect of an amputated leg, where veins had been injected with black neoprene. This shows the anatomy of the small saphenous vein and the external ankle perforating vein

A. General view of dissection
Note the anomaly of the upper part of the external saphenous vein (passes internally to join the internal saphenous vein).

B Close-up of the area of the external ankle perforator with the soleus dissected up and held aside The vein is seen perforating the deep fascia, when it immediately receives a large muscular tributary from soleus, before winding deeply round the inner aspect of the fibula to join the peroneal vein (not visible).

The lower ends of the anterior tibial and peroneal veins communicate with each other freely through the interosseous membrane just above the ankle forming here a small venous plexus The veins from the anterior aspect of the ankle and upper part of the dorsum of the foot and the dorsalis

pedis veins drain into this plexus (This is the route whereby an injection of diodone made into a vein of the dorsum of the foot reaches and outlines the peroneal and anterior tibial veins)

The indirect perforating veins—There are numerous very small inconstant indirect perforating veins dotted over the bellies of the soleus and gastrocnemius muscles They are small, variable, and inconstant differing in these respects from the direct perforating veins, they are so tiny that they are incapable of significant dilatation Moreover, in the lower third of the leg they are practically absent, occurring only over the great muscle bellies The most constant of them are two which perforate the middle of each belly of the gastrocnemius muscle (Figs 42-43).

The perforating veins of the foot between the superficial and deep systems are very numerous indeed (Fig 50)

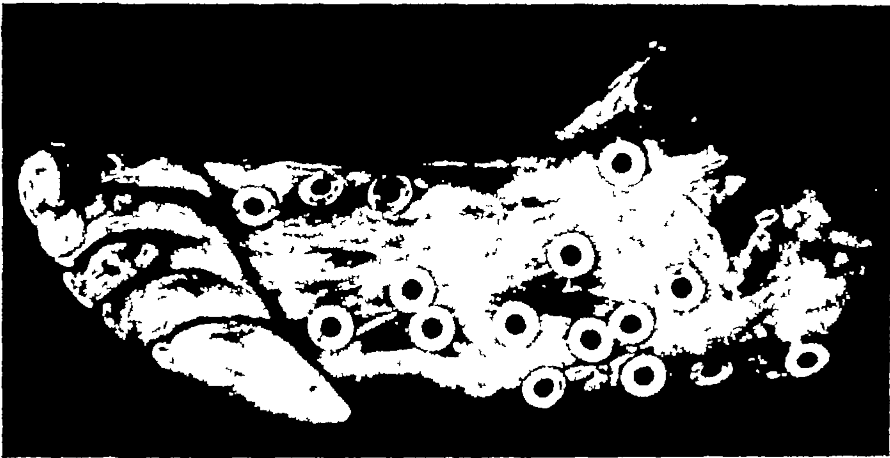


Fig 50

Dissection of the foot showing the numerous sites of the perforating veins Each perforating vein is marked by a paper marker

(By courtesy of D A W Edwards)

THE ARTERIAL SUPPLY OF THE SKIN AND SUBCUTANEOUS TISSUES OF THE LEG AND FOOT

Figure 51 shows an X-ray of the skin and subcutaneous tissues of the lower half of the leg, ankle region and heel which was removed from an amputated limb after the arterial system had been injected with a bismuth suspension (D A W. Edwards) It will be seen that the skin supply down as far as the ankle arises from small perforating arteries, which rapidly break up into a tree-like distribution of arterioles Each perforating artery is more or less directly responsible for a small area of skin but at the periphery of this area the arterioles anastomose freely with those of the neighbouring skin

Many of these small perforating arteries accompany the perforating veins, and in Figure 25c quite a large perforating artery can be seen accompanying the middle perforating vein although it is not closely applied to it.

The arterial supply of the skin of the foot, however differs in being more profuse and coming from larger vessels The heel particularly is seen to have a good arterial supply of many larger vessels arising more directly

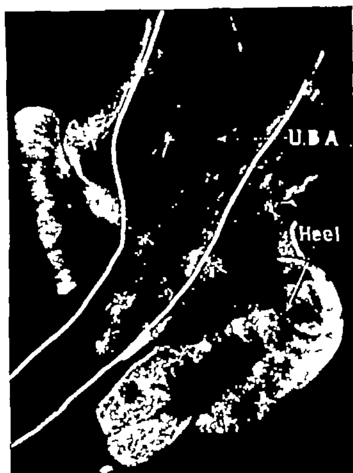


Fig. 51

The arterial supply of the ulcer bearing area (U.B.A.)

This is the X ray of the skin, subcutaneous tissue and deep fascia of the lower third of the leg, which was dissected off in one piece and laid flat. The vessels had been injected with bismuth suspension. The two heavy lines enclose the "ulcer bearing area" (U B.A.). The relative avascularity of this area and the small size of the vessels compared with those of the heel and foot is noticeable

from the posterior tibial artery Figure 51 brings out the difference between the profuse arterial supply of the foot and the sole in contrast to the sparse and poor blood supply of the skin of the ankle region (*i e.*, the ulcer-bearing area = U B A. in Fig 51)

A study of these pictures is of interest in understanding the problems of venous ulceration The small size and paucity of arteries supplying the skin of the lower third of the leg, particularly in the area where

ulceration occurs, is striking It is obvious that if there were a local rise in venous pressure (such as might occur in the vicinity of a large incompetent perforating vein) the effect on the local circulation would be worse than in a region with a larger arterial supply. The circulation to the heel and foot is so copious and carried by such large vessels that it is more difficult to imagine that ulceration would happen here Clinical experience bears this out.

One further important practical point emerges It is apparent that when operating on the lower third of the leg and undercutting a large area of skin in the subcutaneous plane, many of these perforating arteries would be divided and an area of skin easily made ischaemic The only collateral arterial circulation would be by the anastomosis of small arterioles from neighbouring areas of skin whose perforating arteries had remained intact Thus to minimise skin necrosis undercutting must be avoided

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CHAPTER IV

THE PHYSIOLOGY OF VEINS

(WITH SPECIAL REFERENCE TO THE VENOUS RETURN FROM THE LOWER LIMB)

by

CHARLES I MURPHIE F.R.C S (ENGLAND)

DESPITE the empirical use of blood-letting by the ancients and its continuance into modern times the fundamental observations of Harvey in the seventeenth century leading to the concept of a systemic circulation marked the beginning of our present knowledge of venous physiology The function of the veins is to return blood to the heart, and this venous return must be maintained in all the varying activities in which man may participate

Before considering this primary function it is profitable to recall briefly that the veins are thin-walled vessels essentially similar in structure to arteries and which, like them react to nervous, mechanical thermal chemical and possibly endocrine stimuli.

Nervous effects may be local or central in origin thus, veno-constriction may result from the stimulation of the peripheral end of a sectioned nerve or from perfusion of the medullary centres with a fluid of raised carbon dioxide tension Again, the venous calibre may be affected through carotid or aortic sinus reflexes There is in fact a venous tone

The effect of mechanical stimulation is commonly observed notably the reflex dilatation on lightly tapping a vein before venepuncture while every house surgeon will have seen the contraction of the saphenous vein at the ankle on cutting down for an intravenous infusion He will have noted, too the dilatation of the same vein on the application of heat to the leg

No long catalogue of the effects of chemical stimuli is required the constriction with adrenaline, and the dilatation with papaverine, procaine, and with a fluid of raised hydrogen ion concentration is well known

Little is known of endocrine factors, though that they may operate is suggested by the "varicose" tendency during pregnancy the increased prominence of varicose veins during menstruation and in the occasional varices appearing with the menopause (McPheeters and Anderson, 1946)

The heart and the venous return.—The blood flow in any organ varies within wide limits depending upon its activity and metabolic requirements The effect of such variation is diminished somewhat as far as the work of the

heart is concerned by the deflection of blood from one organ to another, for example, during exercise, from the splanchnic area to the muscles. After a meal the reverse occurs. Nevertheless, if the cardiac output is to be maintained the healthy heart must be able to deal with such variations in the volume of venous return. Indeed, in severe muscular exercise the cardiac output is increased to seven or eight times its resting volume (Hill, 1926). In pathological conditions, however, the damaged myocardium may be unable to deal with a greatly increased venous return, and the raised jugular pressure and venous engorgement are a reflection of congestive heart failure. Such a state may be precipitated by recumbency or by elevation of the legs, which will increase an already high auricular pressure. Conversely, sitting with the feet down will be the physiological equivalent of a venesection (Brigden, Howarth and Sharpey-Schafer, 1950). Further, in the healthy heart, increase in venous return is nearly always associated with a rise both in pulse rate (the Bainbridge reflex) and in stroke volume.

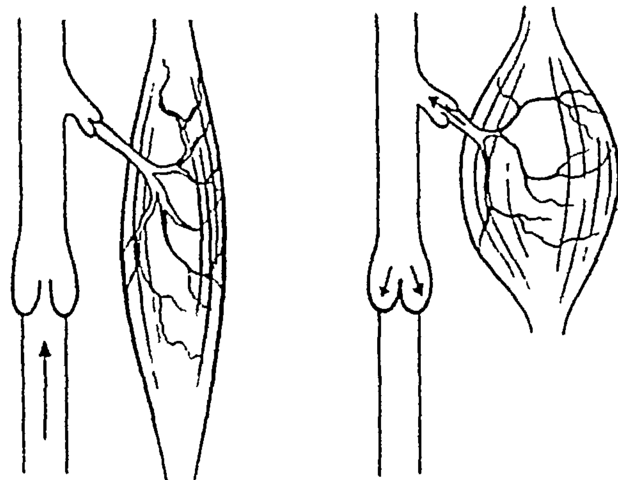


Fig 52
Effect of muscular contraction

Factors upon which the venous return depends

(1) Muscular exercise.—As stated above, the cardiac output is greatest during muscular exercise. Harvey was aware of this and realised further that the muscular contractions must be rhythmical. If they were "tonic" or "static," no increase in output, heart rate or venous return could be demonstrated. With normal alternating contraction and relaxation of muscle there is arteriolar vasodilatation and increased blood flow. With each muscle contraction, the intramuscular and, to a certain extent, intermuscular veins are compressed and blood tends to be driven out proximally, distal flow being prevented by closure of the valves, so that the resultant stream is centripetal (Fig 52). With muscular relaxation inflow takes place by virtue of the "*vis a tergo*" and the process repeats itself. This has been confirmed experimentally and by direct observation in the frog (Jager, 1936). To a lesser extent, the same occurs in "postural" tone, the final result of the alternate contraction and relaxation of groups of muscle fibres. Indeed, the principle is of such importance in controlling quantitatively the venous return that it is now frequently referred to as "the peripheral venous heart." In short, during muscular exercise the venous return and cardiac output are

increased to an extent depending upon the muscles involved and the nature of the exercise

(2) THE EFFECTS OF RESPIRATION —From the earliest times the effect of respiration upon the superficial veins has been observed Valsalva is stated to have seen the jugular vein of a dog distend with expiration and collapse with inspiration and the same effect is commonly observed in the axillary vein during the operation for radical mastectomy With inspiration there is a potential negative intrathoracic pressure (caused by the combination of an increase in thoracic volume and the elasticity of the lung) and this negative pressure tends to draw blood into both the superior and inferior venae cavae (Fig 53) Once again, as with muscular contractions inspiration and expiration must alternate and if for example there is forced expiration against

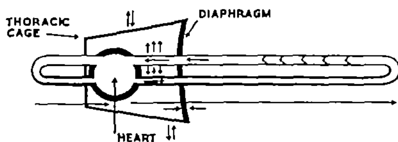


FIG. 53
Effect of respiration on venous return.

pressure of some seconds duration (the Valsalva manoeuvre) the venous return is obstructed and the cardiac output and pulse pressure are diminished (Sharpey-Schafer 1955)

Furthermore, with the descent of the diaphragm on inspiration it is believed that there is a rise of intra-abdominal pressure which not only empties the splanchnic veins but also tends to compress the vena cava and iliac veins In this way if the femoral valves at the level of Poupart s ligament are competent blood is drawn into the thoracic cavity Experimentally however there is no constant finding with regard to intra-abdominal pressure changes with respiration as these depend largely on the postural activity of the abdominal musculature including the muscles of the pelvic floor On the whole however it is probable that there is a slight rise on expiration and fall on inspiration In man the fluctuation is of the order of 4 8 cm water in pure abdominal or deep thoracic breathing (Mettlenleiter 1924) Even though there may be a rise of pressure in inspiration it is by no means certain that there is an increase in venous return Ledderhose in 1906 showed that in a recumbent patient with varices the varicose veins distended with inspiration and diminished on expiration The same was found in a patient with a normal though dilated saphenous vein with competent valves

Further the dilatation was greatest on coughing. Thus it must be concluded that the femoral valves do not close in the conditions of the above experiment and that the blood flow is slowed by inspiration Such has been proved with greater accuracy in the experimental animal by cine-radiography (Franklin and Janker, 1936).

In short, any rise of abdominal pressure will momentarily tend to hinder the blood flow from the lower limb and the reverse will facilitate it. In normal respiration these two will balance and . . . . "variations in venous return unless they are temporary in character can only be produced by variations in the peripheral in-flow, and there is no evidence that this last is seriously affected by the respiratory movements" (Franklin, 1937)

(3) ARTERIO-VENOUS SHUNTS —Another factor may be of importance. It is known that within certain organs arteriolar blood may be shunted directly into venous channels without having passed through the intervening capillaries It is claimed that this may obtain in the leg, and Piulachs and Vidal-Barraquer (1953) have postulated that, when present to a marked degree, varicose veins result They base their hypothesis on their finding that the criteria of the rare cases of haemangiectatic hypertrophy of a limb (Parkes Weber) or "congenital" varicose veins, in which small arterio-venous connections are present, are satisfied Their work is impressive, but as yet unconfirmed.

Venous pressures and hydrostatic effects.—The measurement of venous pressures has always presented a problem to the physiologist *Indirect* methods in which the pressure required to obliterate a vein by means of a cuff is recorded, are inexact, though clinically the simple tests of Sir Thomas Lewis and of Gaertner are in every-day use The former measures the height of external jugular venous distension above the suprasternal notch or "heart level" in the erect man and is most commonly observed in congestive heart failure The latter test determines the level, again relative to the heart, at which a distended vein of the dorsum of the hand collapses

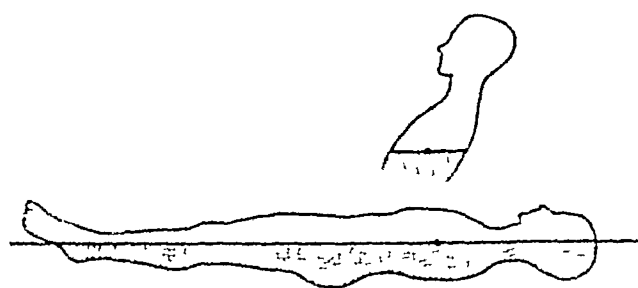


FIG 54
Effect of lying and sitting upon the "heart level," the essential point of reference in the measurement of venous pressure (*after Burch*)

Direct methods are difficult to perform by virtue of the narrow calibre of the smaller vessels and resultant effects of friction In the larger vessels, however, such measurements are possible and it is only in this way that an

accurate recording of venous pressures can be obtained. All methods are based upon that of Moritz and Von Tabora (1910) in which the vein under study is punctured by a needle connected with tubing, preferably polythene, to a glass reservoir containing isotonic sodium chloride The position is found when the meniscus comes to a standstill and the level above the " heart level " represents the pressure within the vein This method has been much elaborated by Burch (1950) and an accurate phlebomanometer constructed (Fig. 54)

His findings have confirmed those of Landis (1934) and the normal pressure gradient of a man lying at rest is shown below

Artery	130 cm water
Arteriole	70 cm water
Capillary	40 cm. water
Venous capillary	25 cm water
Venule	20 cm water
Medium-sized vein (average)	10 cm water

The venous capillary pressure however varies greatly depending upon the activity of the part under investigation. Arteriolar dilatation, as with muscular exercise or the local application of heat, raises the capillary pressure and blood flow whilst the application of cold lowers both Thus the "*vis-a-tergo* depends largely upon the activity of the part under consideration

The pressures set out above were found with hydrostatic factors excluded. It is therefore necessary to examine the effects of gravity upon the animal, and in particular of the erect posture in man (Fig 55)

Both the arterial and venous systems may be regarded as a vertical system of tubes (Hill 1895) and in man standing erect the femoral arterial pressure will be greater than the brachial pressure by an amount depending upon the difference in height of the two vessels As the capillaries are distensible and permeable other things being equal there will be a tendency for blood to

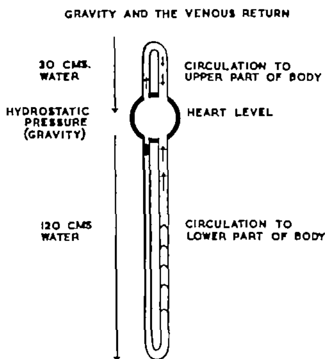


Fig 55
Representation of hydrostatic pressure in man standing erect.

collect in the more dependent parts, such as the legs and splanchnic area Compensatory mechanisms therefore come into play and these vary in different animals In some they are non-existent and the animal held with head erect may rapidly die from cerebral anaemia Normally, however, the distribution of blood is under central vasomotor control while venous tone and the postural contraction of the leg muscles will ensure an adequate venous return In man there is a great variation in such postural compensation largely depending upon habits and general health It is known that in a healthy individual 500 ml of blood may be diverted to the legs after an hour's standing and that the volume of the lower limb may increase by 3 6 per cent under these conditions. Such an increase can be reduced rapidly in the normal subject by lying down or walking In patients long recumbent, these hydrostatic effects are even more marked and the rate of recovery less rapid (Atzler and Herbst, 1923)

Again, in the healthy individual moving from the lying to the standing position there is little change, either in brachial pressure or in heart rate, and a drop in pressure associated with a rise in pulse rate, together with a feeling of faintness indicates a diminished power of compensation Such may be seen not only in cases of heart failure, but in patients after long recumbency

Effects of muscular exercise on venous pressures.—It is now necessary to return to the effects of muscular exercise on venous pressure Carrier and Rehberg (1923) showed that the venous pressure in the superficial veins of the dependent leg could be reduced by muscular contraction Recently Walker and Longland (1950) have confirmed this by cannulating a dorsal vein of the foot with polythene tubing connected to a simple manometric system and have recorded the pressures in various positions A typically normal finding is given below·—

(1) Lying	20 mm. Hg
(2) Standing .	90 mm Hg
(depending on height of right auricle on heart level from the foot)	
(3) Marking time	30 mm. Hg.

A failure of the pressure to fall with exercise was considered to indicate an inefficient venous return If no varices were visible, such incompetence was probably situated in the deep veins. Pressures were taken in a similar manner in otherwise healthy patients with superficial varices only. On marking time there was a drop of venous pressure, on an average to 40-50 mm /Hg

Again, Pollack and co-workers (1949) with the more sensitive strain-gauge manometer have taken pressures in the internal saphenous vein at the

ankle in patients both standing and walking on a treadmill at 1 7 m.p h Their results are tabulated below —

Type of patient	*Decrease of pressure on walking*	*Time taken to regain "standing" pressure on cessation of walking*
Normal.	64 mm Hg.	31 secs.
Varicose veins.	37 mm. Hg.	2 8 secs.
Varicose veins with (old) deep venous thrombosis.	11 mm. Hg.	1 sec.

In this way the effect both of varices and deep venous thrombosis upon the venous efficiency of the limb can be measured, and the vast importance of the action of the venous valves in conjunction with muscular contraction in the maintenance of an adequate venous return is demonstrated. It was long believed that these valves were primarily an antigravity mechanism' though they occurred in parts of the body where such effect was reversed.

In a recent comparative study Williams (1954) has shown that the valves are most plentiful where the musculature is greatest and are quite independent of posture Nevertheless in the human being venous valves are most numerous in the deep veins of the lower limb and upon their integrity the venous return largely depends A recent venous thrombosis will present an obvious obstruction and if it occurs in the deep veins, blood may well be temporarily directed to the superficial system On resolution of the clot, the delicate valves not only in the deep veins but also in the communicating vessels may be made permanently defective In this case the full deep venous pressure will be transferred to the unsupported superficial vessels with the probable formation of varices Further increased capillary pressure will result and give rise to oedema, which only recumbency or the application of external pressure can control As can be seen in the above table muscular contraction is only partially successful in aiding the venous return from the superficial veins when the deep veins are defective.

At the same time it must be realised that muscular contraction *per se* cannot effect a venous return. It is necessary that there should be an adequate *vis a tergo* or pressure at which blood is fed into the venous system This latter probably unaffected by gravity as hydrostatic effects on the venous and arterial side are balanced depends upon the activity of the part in question the degree of capillary dilatation or the number of arterio-venous shunts.

Pressures in varicose veins.—In the absence or failure of the anatomically variable valves in the femoral vein it can be seen that both the hydrostatic

and intra-abdominal pressure will be transferred to the deep veins of the leg Further, if the valves in the communicating veins are faulty there will be similar changes in the superficial veins

Delbet (1906) found the apparently enormous pressure of 200 mm. Hg in the proximal end of a divided internal saphenous vein in a patient who was straining W. Turner Warwick (1931) made observations upon rectal pressures, which accurately reflect intra-abdominal pressures, during various activities, and his results are shown below —

Rest —Resting rectal pressure is 20 mm Hg.

Breathing.—With ordinary inspiration this reaches about 30 mm. Hg; with deep inspiration the pressure reaches 100 mm Hg. With violent coughing the pressure peak reaches 200 mm Hg or more During violent paroxysmal coughing the pressure is sustained at 185 to 190 mm Hg.

Defaecation.—With hard straining, as in defaecation, the pressure reaches 100 to 130 mm. Hg

Work.—On lifting against weight, the pressure reaches 100 to 130 mm. Hg

" Some of these readings are of the same magnitude as that obtained by Delbet, and if it is assumed that the femoral valve is absent, the accuracy of his observation need not be questioned Even if the femoral valve is competent, blood from the femoral segment must at times be returned from the limb in the presence of these high abdominal pressures, and thus the results recorded by Delbet would not be impossible for the femoral segment, and therefore for an unprotected saphenous system "

Venous flow in the lower limb.—Hitherto, the term " venous flow " has been used rather loosely in the sense of total volume flow and this has been taken to vary inversely with the venous pressure. Volume flow may also be taken as a component of linear venous velocity, and the recent introduction of radio-isotopes has enabled study upon this aspect of venous physiology. Payling Wright and Osborn (1952) using radio-active sodium have studied the effects of posture and simple movements under standard conditions upon the rate of flow from the ankle to the groin. Regarding the rate of flow in the horizontal position of the leg as normal, they found that the rate was halved when the subject stood and doubled when the leg was raised to an angle of 10° above the horizontal, or when the foot was vigorously dorsi—and plantar-flexed Previous studies of the speed of flow in pregnancy showed constant slowing, which rapidly returned to normal in the puerperium (Payling Wright *et al.*, 1949, 1950). The importance and application of these findings in the study of venous thrombosis and varicosis is obvious.

Stanton and others (1949) have studied the effects of local compression on the venous velocity. Using " pressurised suits " they showed that the application of a pressure of 20 to 35 mm Hg. to the lower extremities gave

an increase in venous velocity measured by fluoroscopy radiography or foot to-tongue circulation time. Further there was no alteration in the distribution of the contrast medium (diodrast) between the superficial and deep veins They drew the conclusion that this increased velocity was due to a diminution in the total cross-section area of the venous bed. It may well form the basis of the rationale of treating the varicose or post-phlebitic ulcer the results of a poor venous return, by the application of support in the form of extensible pressure bandages or elastic stockings treatment—let it be added, advocated by Galen and in common practice in England in the fourteenth century!

As far as the actual venous pathways are concerned, W Turner Warwick in some classical experiments showed that in the normal young adult free from varicose veins blood in the superficial system continued to flow in that system or reached the deep veins through the communicating vessels There was however no flow from the deep to the superficial veins provided the valves in the communicating veins were competent, and indeed on retrograde injection into a deep vein the vein would burst before the valves gave way His anatomical findings have stood the test of time and have been confirmed by phlebography in the living person.

No direct comparison however in either venous velocity of volume flow between the deep and superficial vessels of the lower limb has been made. Technically by any method this is difficult and uncertain For the moment it is tacitly assumed that the normal saphenous flow is approximately 10 to 20 per cent. of that in the femoral vein (Franklin 1937) and it is probable that this percentage remains constant both during exercise and at rest.

Indeed that the saphenous systems are physiologically unimportant is shown by the fact that they may be obliterated almost with impunity It is only when a massive deep thrombosis occurs that blood is temporarily and sometimes permanently deflected to the superficial system with resultant swelling, possibly varicosities and later ulceration

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PART II

PATHOLOGY AND SURGERY OF SUPERFICIAL VEINS



Fig 56

Fig 56

Incompetence of the internal saphenous vein with fair skin condition at the ankle

Fig 57

Internal saphenous incompetence with skin changes at the ankle unsightliness and loss of hair B shows that the veins are completely controlled by a tourniquet round the upper thigh

A Fig 57 B

CHAPTER V

THE SYMPTOMS OF VARICOSE VEINS

VARICOSE veins are prone to appear spontaneously throughout life, even to the age of seventy but especially from adolescence onwards Women are more conscious of their varicose veins at menstruation and during pregnancy These are times of increased endocrine activity which suggests that hormones play a part in their activation.

To many varicose veins give no trouble they are but a disfiguring (Fig. 56) Other patients complain of varying degrees of discomfort, disability itching, pain, swelling, skin changes, eczema or ulceration These are symptoms and complications.

The explanation of the difference between patients with apparently the same condition lies in the extent of the venous disorder for it may involve only the saphenous veins or include the perforating and deep veins. With the former there may be little superficial change beyond the presence of the varices, with possibly attacks of phlebitis With deep venous incompetence and failure of the valves of the perforating veins in the lower half of the leg, patients complain not of the varicose veins but of unsightly skin changes swelling, eczema ulceration pain and impaired function

Some patients assert that their varicosities don t bother them although they are often gross but when they have been treated usually for aesthetic and precautionary reasons they admit that their legs feel better One of us recalls a man who sought operation because his large varicosities were an anxiety to his wife he was emphatic that they were causing him no trouble. After ligation he reported that his legs were easier and lighter he could walk better and farther and was no longer tired and reluctant to take exercise in the evening (Fig. 58)

Some seek treatment because their varicose veins prevent them obtaining an appointment in the navy army air force, police or other service

Fear of the unsightliness, swelling eczema ulceration and incapacity that they have seen afflict their parents, relations or friends, frequently causes patients to seek advice.

DISFIGUREMENT —Varicosities are an annoyance to their owners and to others Vanity plays some part here, but early treatment may be desirable Varicosities give many persons an inferior and asocial feeling, causing them to be solitary preventing them from wearing summer clothes and from participating in recreation including bathing

SKIN CHANGES —A limb with varicose veins is subject to harmful and disfiguring changes as their degree and extent increases with time

The leg and foot are usually somewhat cyanosed on standing.

Yellowish-brown discoloration is frequent over recently developed varices and around those injected with sclerosants It follows after superficial phlebitis. The friction of clothes over protruding veins causes it.



FIG. 58
Gross varicose veins due to incompetence of the internal and external saphenous veins (before and after operation)

Pigmentation appears in patches or in spots, especially above the internal and external malleoli, *i.e.* in the ulcer area when it may encircle the part.

Scaliness (Fig. 59), eczema or ulceration are later developments

Aching and/or pain in the legs ranging from slight to severe is possibly the commonest complaint. It is noted in several forms Aching in the day or in the evening or both The discomfort may be pricking and pulling in the lower limbs during exercise Fatigue and undue tiredness at night are common

Pain in the thigh from varicose veins seldom occurs although we have seen a few authentic cases one patient said the thighs felt "wooden"

The lower limbs, especially the legs may be tender to touch One man stated that his entire limb was "uneasy"



FIG. 59
Scaliness of the skin over varicose veins.

Varicosity of the internal saphenous vein, especially of the posterior arch or anterior leg tributaries, gives discomfort such as aching, tightness and a "heavy" feeling in the ankle and front of the leg on prolonged standing and towards the end of the day

Varicosity of the short saphenous system causes pain and aching in the calf which may also be felt in the heel and foot. Pigmentation eczema and ulceration in the post malleolar grooves is fairly common.

The long saphenous vein is accompanied by the saphenous nerve and the short saphenous vein by the sural nerve. Any inflammatory changes about these vessels as in phlebitis (spontaneous or chemical from injections) may give pain either continuously or in paroxysms of intense burning in the

leg, heel, dorsum or sole of the foot If these nerves are injured during the injection or operation for varicose veins patients complain repeatedly of the resulting impaired sensation

Incompetent ankle communicating veins are a fertile source of pain and tenderness below the knee They are associated with varying degrees of deep venous incompetence, and varicose veins They cause early tiredness, sensations of weight and weakness in the foot and ankle on walking and standing The dorsum of the foot is swollen and the retro-malleolar grooves are obliterated, with loss of shapeliness of the ankle and leg. Discoloration, itching, eczema and ulceration follow in an inevitable and orderly sequence in one to thirty years after the inception of the incompetence

Patients with varicose veins who complain of bursting sensations and pain in the calf frequently have had deep phlebitis It is always suspected if in addition there are skin changes in the lower leg and oedema of the ankle and foot Venograms will confirm the diagnosis, for there may be no history of deep phlebitis Myers and Cooley (1954) conclude from their study that " in a certain number of cases definite injury to the deep veins by thrombophlebitis occurs without recognition." We accept this opinion.

Haemorrhage may be spontaneous or follow a blow. It may be closed or open : the former is due to a ruptured venule and causes an area of black cutaneous staining Bleeding from a ruptured varicose vein may be torrential and frightening to the uninformed who are unaware that sustained direct pressure or raising the limb would stop it It may be the starting point of an ulcer or eczema. Considering the size, number, and pressure in varicose veins, haemorrhage is rare In March, 1955, a patient was brought to one of our hospitals fatally exsanguinated by haemorrhage from a ruptured vein in the base of an ulcer

The function of the limb is noticeably affected, especially in those with incompetent ankle perforating veins It becomes weak and readily fatigued. It may feel heavy; one man said his leg was " like dragging a load behind me." Muscle spasm and cramps may be experienced by day or by night. Bursting feelings in the leg muscles and sensations of heat or of cold occur. The unsteadiness of patients with varicose veins and ulcerated legs is apparent during the clinical examination Walking up and downstairs, standing and carrying is an effort or is limited.

Obesity.—This is sometimes pronounced; it results partly from the inactivity imposed by the discomfort from the varices and their complications and also from the prolonged periods of rest which are often erroneously advised for these persons The lower limbs may become excessively fat and oedematous, so obscuring the varicose veins

Hair.—A limb with marked varicose veins often loses its hair. This is particularly so in the pre-ulcerous, eczematous stages and always in ulceration So constant is this that we generalise and say that a hairy leg is a healthy

eg One patient after his operation for varicose veins remarked with satisfaction that the leg was no longer " bald

Swelling—At the outset we would emphasise that swelling is *not* a symptom or sign caused by uncomplicated superficial varicose veins It is essentially a sign of deep venous thrombosis or post-thrombotic perforator



FIG. 60
Oedema and ulceration of the legs after bilateral deep thrombosis.

vein incompetence (Fig. 60) but it is often *present* with varicose veins and its allied conditions It varies according to the age of the patient, the duration and extent of the varices It is worse during menstruation and pregnancy towards the end of the day in warm weather and in hot places, *e.g.*, in a bakehouse or kitchen It is first located at the dorsum of the foot then under and behind the malleoli and later above the ankle, and may extend to the knee. Comparative measurements around the ankle, mid-calf and below the knee are illuminating and valuable for a record of progress

Swelling is a frequent complaint that may or may not be associated with venous disorders Patients seek advice in the hope that such a cause is present and is amenable to treatment

The causes of swelling of the legs are manifold Sometimes they are single and at others composite The explanation may be a local or a general one, or a combination of the two It is not our purpose to include a dissertation on this vast subject, but the following are likely to be seen in a leg clinic

1 Congenital, unilateral or bilateral, Milroy's disease (Fig 61) and lymphoedema praecox

2 Congenital arterio-venous fistula

3 Post-traumatic swelling as after a wound, fracture, burn, or poisoned bite Swelling after trauma is prone to be a composite condition with changes in the bones, soft tissues, veins (thrombo-phlebitis, deep and superficial) and lymphatics

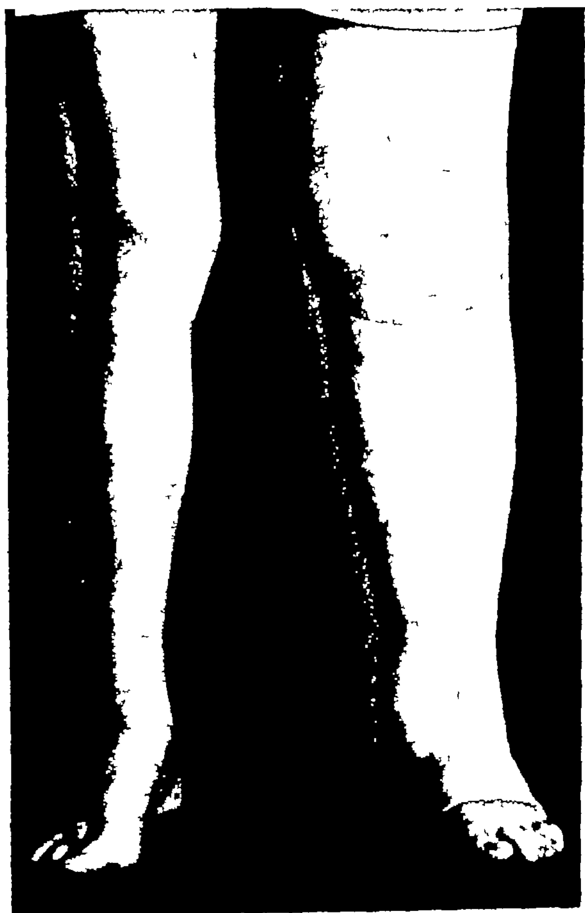


Fig 61
Left Milroy's disease

4 Post-infectional states in the skin, fat, fascia, muscles and joints These are linked up with the previous group where infection is frequent Again, the changes are in the tissues, veins and lymphatics to varying extents

5 *Deep venous thrombosis* or its sequelae of defective deep and communicating veins

6 Legs grossly ulcerated from venous disorders (Fig 62)

7 The various manifestations of erythrocyanoid affections of the legs (Fig 63)

8 Lymphatic disease *obliterative* lymphangitis, or obstruction to the lymphatic drainage

9 Constitutional diseases, such as cardiac, blood, respiratory, renal and nutritional conditions.

10 Postural (prolonged sitting position), due to heart and joint disease

11 Mechanical pressure on the abdominal veins as by a pregnant uterus, a huge abdominal tumour, an impacted swelling in the pelvis or abdominal carcinomatosis

12. Endocrine imbalance, adiposa dolerosa, myxoedema, prolonged administration of stilboestrol



Fig. 62
Swelling and ulceration of the left leg due to a previous white leg and varicose veins.

Fig. 63
The erythro-cyanoid limbs showing the slight swelling.

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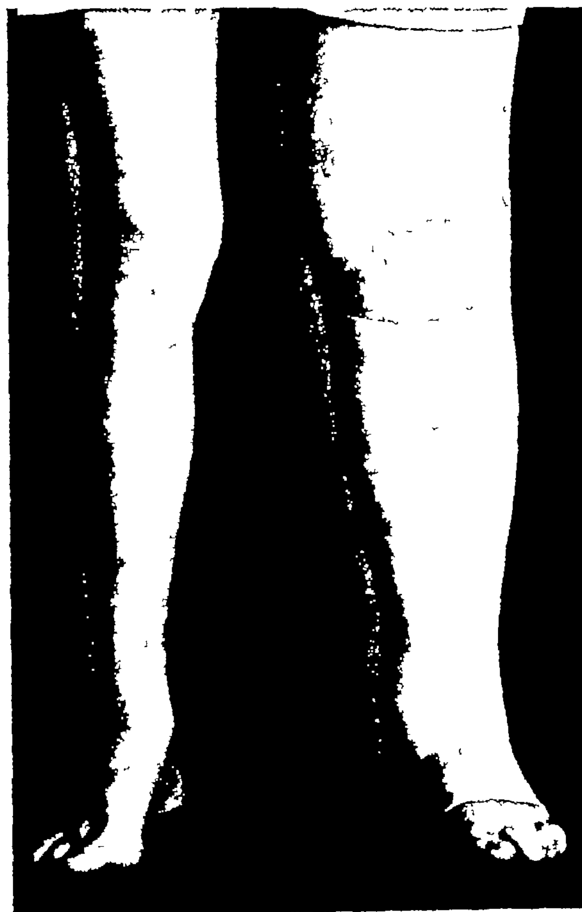


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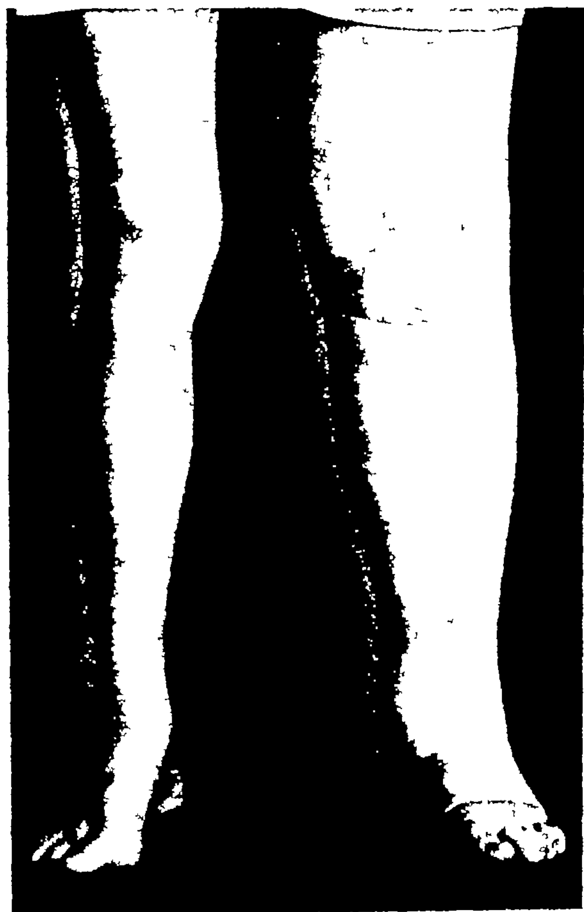


FIG 61
Left Milroy's disease

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FIG. 62
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FIG. 63
The erythro-cyanoid limbs showing the slight swelling.

Other ailments causing pain in the legs.—When superficial varicosities are present, discomfort felt in the lower limbs is liable to be attributed to them, but many other conditions can cause this symptom Further, there may be multiple pathological processes for example, varicose veins, incompetent deep veins and arteriosclerosis may affect the same leg Likewise affections of the skin, fat, fascia, muscles, bones, joints, nerves and lymphatics may be present in the lower limbs and factors suggesting them should be remembered in routine examinations The diagnosis of varicose veins with the patient lying down and getting up for the tourniquet tests gives an opportunity for assessing the condition and function of the limb such as muscular strength and range of joint movements

Leg symptoms may be caused by general disorders such as diabetes, pregnancy, intervertebral disc lesions, and arteriosclerosis

Pain may follow the resumption of duty after influenza, tonsillitis, or other toxic conditions, and it may be due to loss of muscle tone or unnoticed venous thrombosis

Obliterative or spastic arterial disease, seen more often in men, causes pain on walking, intermittent claudication, and especially rest-pain on going to bed

The complaints of heaviness, weakness, weariness, excessive perspiration, itching, eczema, or excruciating pain, besides being associated with venous disorders may arise from strained ligaments and joint lesions of the foot, ankle, knee and hip Patients with painful osteo-arthritis of the hip and knee may attribute this to their slight varicose veins, rheumatoid arthritis especially exercises a bad effect in venous disease by limiting the calf-muscle pump action

When conditions concurrent with varicose veins and their allied ailments are recognised and treated, the beneficial results are enhanced.

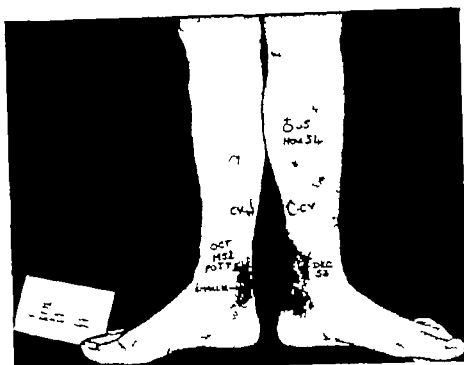
CASE-TAKING AND EXAMINATION OF THE PATIENT

The effective treatment of varicose veins depends in a large part on a correct diagnosis, for their treatment, *i e*, the operation or injection for them, although requiring scrupulous attention to asepsis and to detail, are elementary surgical exercises

Attention is paid to the patient's complaint and reason for seeking treatment: it may range from vanity to incapacitation

History.—The history is always significant The duration of the varicose veins and the incident which the patient thinks caused them may be helpful.

DEEP THROMBOSIS —It is essential to enquire for an unreported or unrealised attack of deep thrombosis that has been associated with an injury such as a fractured spine, pelvis, femur, tibia or ankle; an operation below the diaphragm, such as on the alimentary canal, kidneys, pelvic viscera or



A



B

FIG. 64

Bilateral deep thrombophlebitis after a Pott's fracture, before and after ligation of the ankle perforating veins.

6n

legs. *e g* a young man had a cartilage of the knee removed, and developed a white leg in the opposite limb, another had Pott's fracture and deep thrombophlebitis ensued in both legs (Fig 64). Phlegmasia alba dolens may have complicated parturition or a medical illness Prolonged immobilisation for any reason is noted Further thrombosis, deep or superficial, may occur spontaneosly during health. Swelling of the foot and leg, persisting for several weeks, are suggestive of it, *e g* after trivial injuries like a scald, gnat bite or graze

Previous injections of varicose veins, or operations for them are asked about, and their effects immediately and later

SUPERFICIAL THROMBOPHLEBITIS — Former attacks of spontaneous thrombophlebitis are enquired for Leading questions are occasionally necessary The deep veins may have been affected similarly at the same time, with valvular incompetence developing on their recanalisation

DIABETES —Diabetes is occasionally a predisposing and continuing factor in ulceration and eczema The patient may know of it but be unaware of its relevance, and therefore not report it Every patient with an ulcerated or eczematous leg must have the urine tested for sugar several times its detection facilitates recovery and avoids clinical humiliations

ULCERATIVE COLITIS —The bowel action is checked, for the patient may have, or may have had, ulcerative colitis, which he does not associate with the leg condition and is therefore not mentioned This disease can be complicated by recurrent ulceration of the legs (Fig 289)

ANAEMIA —Chronic ulceration often causes marked anaemia due to the daily discharge and sepsis One of our present patients is a woman with pernicious anaemia and varicose veins whose chronic ulceration of the leg is prone to reappear, especially in the winter The blood count has always shown a considerable anaemia with the re-ulceration

THE FAMILY HISTORY —In 100 consecutive cases of varicose veins, 79 per cent had a definite family history, 17 per cent had none and 4 per cent did not know Thus varicose veins appear to be familial in approximately 79 per cent of cases Therefore their existence in the mother (especially), father, and family is enquired for. Occasionally patients are ignorant of the tendency until questioned, and on a subsequent visit they will report that a relative or relatives suffer from the condition Piles are a frequent enough association to reward the enquiry of them

In respect of the hereditary tendency to varicose veins King (1950) says, " In view of the frequency with which it (*i e* varicosis) is found in the general population such family incidence would be expected to occur " " The hypothesis of the weakness of the vein wall of a hereditary type is pure speculation without any adequate support " In spite of these remarks we are

RECTAL EXAMINATION.—Digital examination of the rectum may reveal an impacted tumour, thus explaining a unilateral oedema of the leg. On the examining finger blood, pus and mucous of ulcerative colitis or carcinoma, may be noted The character of the prostate will be noted



FIG 69
Examination of the abdomen, A fibroid tumour is present The patient complained of varicose veins and eczema at the ankle.

SEPTIC FOCI —In patients with spontaneous recurring thrombophlebitis, recurrent or intransigent ulceration or eczema of the legs, a retarding effect on recovery may be exercised by a septic focus, such as by an infected nasal

sinus a dead and infected tooth septic tonsils or their remnants, cholecystitis cervicitis and ulcerative colitis Their detection and elimination improves the general health the healing and the permanence of the recovery





FIG. 70 FIG. 71

FIG. 70 X ray of a tibia with intransigent eczema of the leg and ulceration at the ankle after osteomyelitis of the tibia. A pure growth of tubercle bacilli was cultured from this Brodie s abscess.

FIG. 71 An osteoclastoma of the tibia, which was causing swelling, eczema and ulceration at the ankle.

Other Investigations

BLOOD PRESSURE AND HYPERTENSION —The blood pressure is taken because about 50 per cent. of middle-aged women with chronic ulceration of the legs are hypertensive which is of aetiological significance (Valls Serra 1946 and Anning, 1954)

OSCILLOMETER.—The average swing of the oscillometer needle when the cuff is distended to the patient s systolic pressure is 15-60 calibrations.

It is often impaired in the affected thigh and/or leg, and may be widely different in the two limbs The oscillometer reading indicates the distensibility of the arterial wall A rigid artery is incapable of variation in its calibre, and little or no movement is recorded by the instrument, despite the fact that there may be some blood flow in the vessel A distensible artery can carry more blood as the limb needs it A rigid artery has a limited capacity, and when the demand exceeds this, ischaemia with pain follows The readings are taken at the middle of the thighs, below the knees and above the ankles.

THE URINE —The urine is examined especially for sugar as glycosuria is frequently overlooked and is not uncommon with ulceration

THE BLOOD —The blood is investigated, surprising degrees of anaemia are sometimes present, occasionally pernicious in type In one instance, a high blood sugar was found, although the urine was normal The patient had an intransigently ulcerated leg and an abnormally high renal threshold for sugar Suitable dieting restored the normal values, and the ulcer healed

The Wassermann *reaction is determined, especially in those cases* where the ulcer is on the outer calf, or is suspect for other reasons

X-RAYS —The *pelvis, thighs and legs* are X-rayed as the clinical findings indicate They may show calcified arteries, a Brodie's abscess (Fig 70), Paget's disease, or a new growth of the tibia (Fig 71), osteo-arthritis of the joints, or periostitis in the region of the ulcer, a foreign body, etc After a fracture or osteomyelitis of the tibia, persistent swelling, eczema or ulceration of the leg may present years later as sequelae of an associated thrombosis of the deep veins or a residual focus in the bone, *e g* osteomyelitis.

Special investigations

PHLEBOGRAMS AND ARTERIOGRAMS are invaluable and necessary in obscure cases (*see* Chapter XIIIA), but for most patients clinical tests are adequate Phlebograms are done when the clinical findings remain indefinite, and when data is required of the state of the deep veins, and of the site of incompetent communicating veins

VENOUS PRESSURES —The measurement of the venous pressure gives an idea of the venous efficiency of the limb (*see* Chapter XIIIB), it is complementary to a phlebogram

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CHAPTER VI

THE DIAGNOSIS OF VARICOSE VEINS

THE elicitation of physical signs and their integration into a comprehensive diagnosis is an intriguing clinical exercise and leads to effective treatment, satisfying alike to patient and doctor

At the outset, it is pertinent to say that we must be aware of the whole patient as well as of the lower limbs

The following table gives the diagnosis of varicose conditions which one of us operated on during 1954 Their variety will be noted.

Diagnosis	*Right*			*Left*			*Right and Left*			*Total Male*	*Total Fem.*	*Total Pats*
	Male	*Fem.*	*Total*	*Male*	*Fem.*	*Total*	*Male*	*Fem.*	*Total*			
V V s long saphenous	15	27	42	21	24	45	16	18	34	52	69	121
V V s Recurrent long saphenous	9	10	19	8	11	19	4	4	8	21	25	46
V V s short saphenous including recurrent	4	3	7	6	6	12	1	1	2	11	10	21
Incompetent ankle communicating veins	10	14	24	13	18	31	8	8	16	31	40	71
Recurrent ankle communicating veins	1	2	3	2	5	7	2	2	4	5	9	14
Incompetent ankle communicating veins and varicose long saphenous veins	4	4	8	6	12	18	4	7	11	14	23	37
Recurrent ankle communicating veins and varicose long saphenous vein	6	8	14	(Lt. or Rt. not recorded)						6	8	14
Varicose veins in pregnancy (long saphenous)								1	1		1	1
Sapheno-femoral ligation for superficial thrombophlebitis				1	1	2				1	1	2
Totals	49	68	117	57	77	134	35	41	76	141	186	327

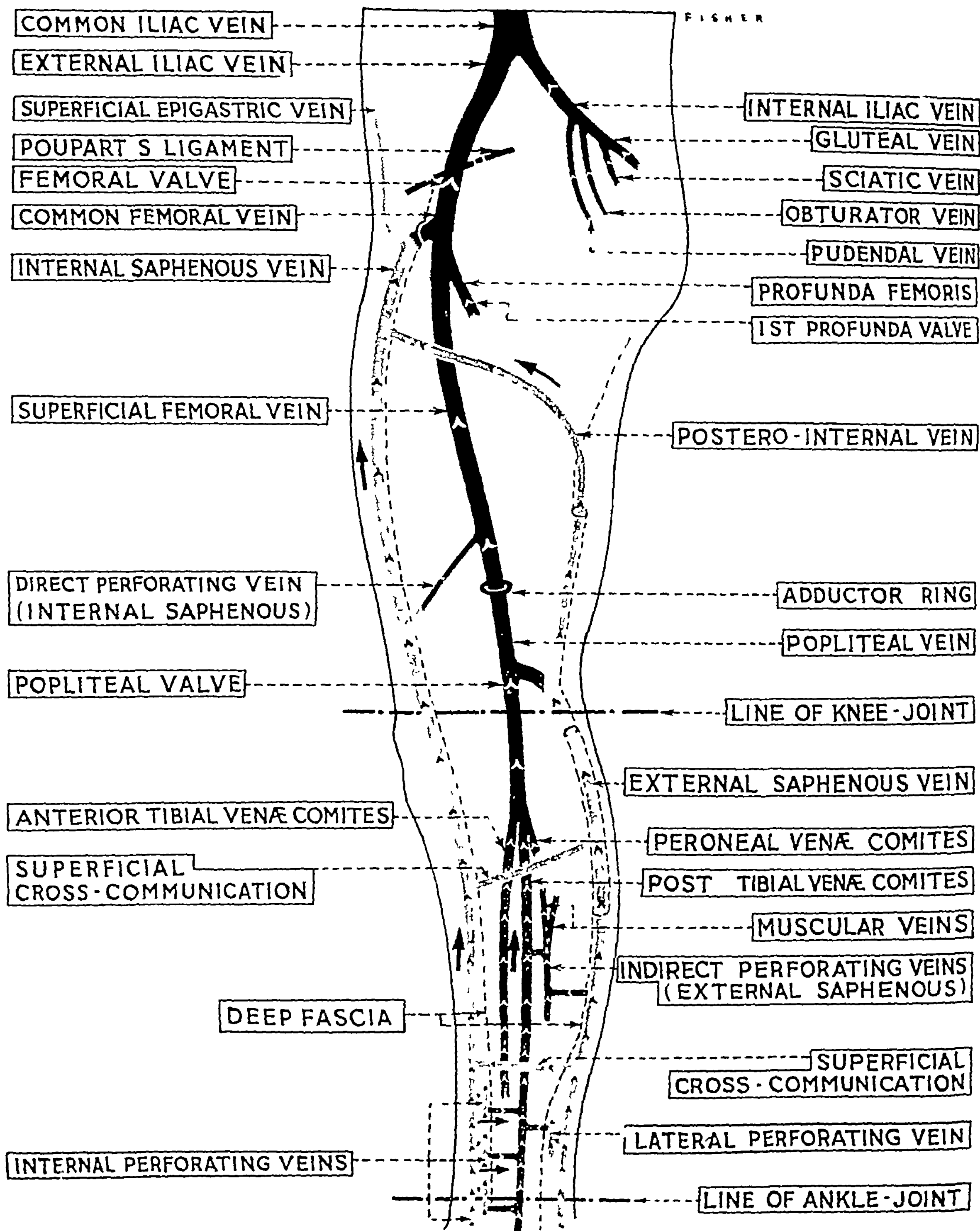


FIG 72
A diagrammatic rendering of the veins of the lower limb

A description of the diagnostic tests [illegible] results and interpretations will be given. A [illegible] and repetition occurs, but it is hoped that [illegible] of the basic principles. Systematic testing will [illegible] diagnosis we strongly urge it.

A review of the venous anatomy of [illegible] 72, is suggested.

INSPECTION

The complete scrutiny of the abdomen [illegible] described in the section on the examination [illegible]

PALPATION OF VARICOSE VEINS

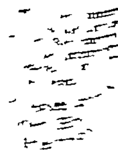
After the inspection the veins are palpated.

The "cough impulse" test.—In this test the fingers [illegible] of the enlarged internal saphenous vein *below* the foramen ovale. Upon coughing, it is usual to feel an expansile impulse in a grossly varicose long saphenous trunk. This impulse is communicated to the varicose tributaries down the leg, and occasionally is so marked that it gives a thrill. The "cough impulse" test is less delicate than the tourniquet test, but it is rapidly performed.





Technique — The pulps of the fingers are placed on the prominent enlarged veins in the leg or thigh the patient is asked to turn the face to the ceiling and cough vigorously. The result varies from no impulse being felt to an expansile impulse and to a coarse thrill with the grosser valvular defects. The impulse is best felt one to two inches below the termination of the internal saphenous vein the landmark for the latter is a point 1¼ inches outside and below the pubic spine (Fig. 73). Sometimes a varix is visible or palpable here, or in an average varicose internal saphenous [illegible] seen or palpated and rolled under the fingertips [illegible] saphenous glands may conceal it. Many heal[illegible]



7

and the husky clearing of the throat, which they produce, might be mistaken for lack of co-operation

EVALUATION OF THE "COUGH IMPULSE" TEST.—When a cough impulse is present it signifies that the long saphenous vein is grossly defective and that only a sapheno-femoral ligation and stripping will be effective in treating the varicosities Further, a thrill in the vein on coughing indicates not only incompetence of the terminal saphenous valve, but also that there is no competent valve between the sapheno-femoral union and the right auricle, *i e.* that the valves in the common femoral and iliac veins are absent or ineffective At operation on gross internal saphenous varicosity, the transmitted venous pulse and collapse with inspiration can be observed in it

This test, to be truly positive, must give an impulse in varices in the thigh At the foramen ovale an impulse can occur in the normal femoral vein, due to the absence of valves in it and the external iliac vein (in 30 per cent of persons) although the terminal valve of the internal saphenous vein is sound (Fig 73)

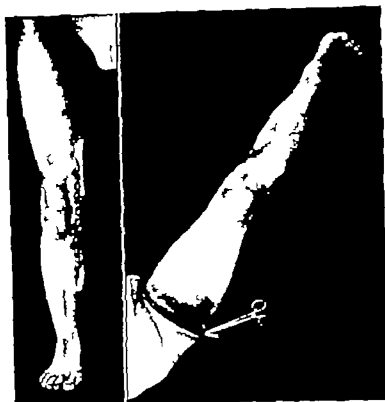
A further error with the "cough" sign is to regard the slight jerk of the muscular contraction that occurs in the lower limbs when some patients cough for an expansile impulse

The percussion test (Schwartz's tapping test).—This test described by Chevrier (1908) and associated with Schwartz's and Homans' name (1922) is carried out as follows —

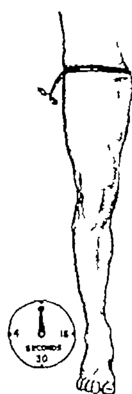
The examiner places two fingers lightly on the region of the foramen ovale whilst with the index finger of the other hand the varicosities above or below the knee are tapped smartly The test is also carried out in reverse If the internal saphenous vein is incompetent, an impulse is discernible by the lower or upper palpating fingers It denotes a column of fluid unbroken by valves, extending from the sapheno-femoral junction to the varicosities below The test is used only in those with obvious varicose veins In a person with an incompetent internal or external saphenous vein, an impulse can be made to pass up and down the defective vessels with the same rapidity that a vibration can be felt in a taut wire *It is especially of service for rapid approximate diagnosis in the gross varicosities It is helpful in determining whether a group of varicosities are in direct connection with the long saphenous system or with the short saphenous catchment area.* If, while the sign is elicited, the patient is asked to shut the mouth and blow, in a varicose vein the impulse is accentuated We regard the percussion test as more sensitive than the cough impulse test, but less so than the tourniquet test

TOURNIQUET TESTS

For these tests, a tourniquet of soft, thin-walled rubber tubing 1-1½ cm in diameter, secured with a large pair of artery forceps, is satisfactory The band is applied tightly enough to occlude the superficial veins



A B





C D

Fig 74

The test for an incompetent communicating vein by a single tourniquet. Figures A to D the incompetent communicating vein is in the mid thigh.

Technique of tourniquet tests.—The patient lies on a couch and the leg to be tested is raised vertically The veins are emptied by stroking them firmly with the hand to the groin The tourniquet is put on sufficiently tight to compress the superficial veins (Fig 74B) The patient stands Some, especially the obese, find difficulty in doing this with a painful, constricting band in position, so that it should not be tightened too much

The single tourniquet test (Brodie-Trendelenburg test).—The single tourniquet test will be described first because it demonstrates basic principles. Routinely we use the double or treble tourniquet according to the patient's veins If they are massive and widespread, more than one filling source is likely and the three tourniquets are used If they are moderate in extent, only two bands are applied, for the diagnosis is often a single one in such cases

The Brodie-Trendelenburg test was described by Sir Benjamin Brodie in 1846. Later, in 1891, Trendelenburg established its significance Since that time its application and usefulness have been increasingly realised The test forms the basis of the diagnosis of superficial varicose veins Sir Benjamin Brodie wrote the following instructions for it —

" If I put on a bandage and squeezed the blood out of the veins below and then put my thumb on the vena saphena magna above so as to stop the circulation through it, I found on taking off the bandage, the patient being in the erect posture, that the cluster of veins below filled very slowly and only from the capillary vessels, but if the patient being in the erect position, I removed the pressure from the vein, the valves being of no use, the blood rushed downward by its own weight contrary to the course of the circulation and filled the varicose clusters below almost instantly "

More accurate results are obtainable if it is carried out by tourniquets The levels on the limb at which they are applied vary according to the veins under examination

STAGE 1 (UPPER THIGH)—The patient, undressed up to the abdomen, lies supine The affected leg is raised vertically, the veins are emptied and the soft rubber band is held by an artery forceps round the upper thigh The patient then gets up *e g* on the couch or on a stool, and the limb below the tourniquet is watched in a good light Five results are possible —

With the tourniquet in position

1 If no veins refill within twenty to thirty seconds, the short saphenous and communicating veins below the band are sound (Fig 74C)

2 If within twenty to thirty seconds the veins refill visibly and are felt to contain blood on palpation, there is a defective perforating or short saphenous vein below the the tourniquet, and further localisation is required (Fig 74D)

When the tourniquet is removed after thirty seconds

1 *Negative* If no obvious immediate filling of veins follows, the valve at the sapheno-femoral junction is efficient and the test is judged to be negative

2 *Positive* If the veins clearly distend from above-downwards, this indicates that the terminal internal saphenous valve is defective, the flow through the internal saphenous vein is reversed during the vertical position and the test is positive. The filling varies from a barely perceptible downward wave to an impressive distending cascade (Fig 75)

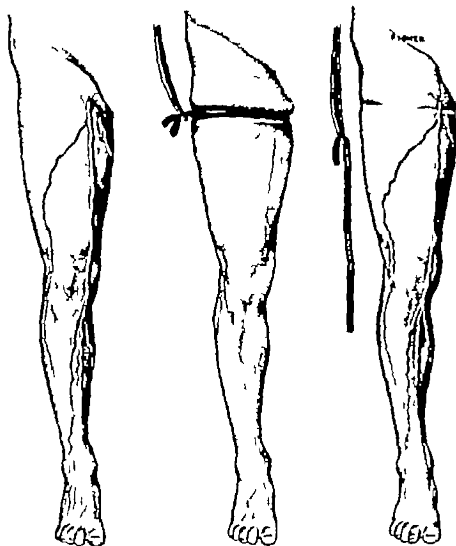


FIG. 75
The test for the incompetent internal saphenous vein.

3 *Double-positive* When the varices fill somewhat within thirty seconds while the band is in position and when it is released they visibly become more prominent and on palpation more tense, a *double-positive* finding is declared These signs indicate defective valves in the internal saphenous vein and in the external saphenous or a communicating vein below the band.

STAGE 2 (LOWER THIGH)—When defective veins have been detected below the constriction the veins are emptied, the band is applied *at the lower*

third of the thigh This controls the communicating vein passing into Hunter s Canal The patient stands Three findings are possible —

1 *Negative* If the varicose veins below the band remain empty, this signifies (*a*) that the faulty vein or veins lie above the band, and (*b*) that the

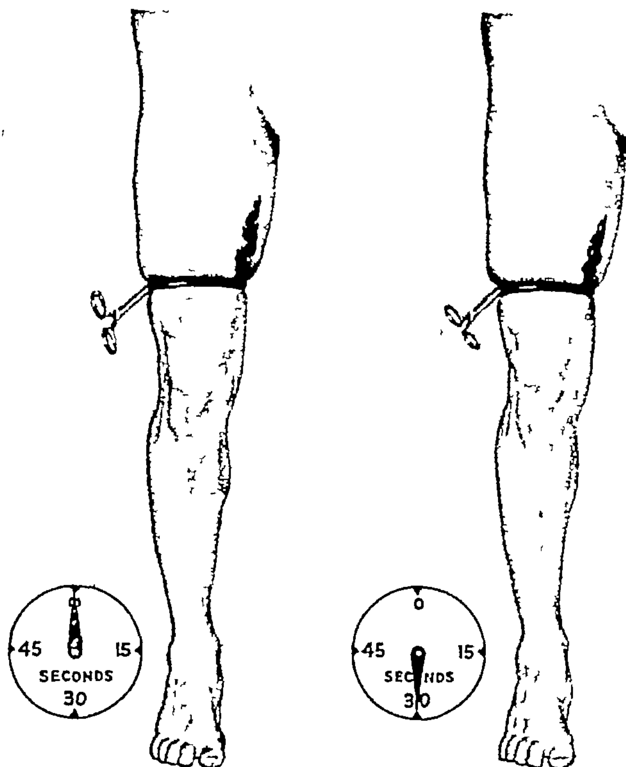


FIG 76
"Single" tourniquet test above the knee, indicating that the communicating veins below the band are sound

external saphenous vein and the perforating veins below the constriction are sound (Fig 76)

2 *Positive* If the veins distend distal to the band, the fault must lie below it, and may be due to an inefficient short saphenous vein or a defective perforating vein of the leg, lower fourth of the thigh, or to both

3 If veins soon appear above the band, the filling is from the internal saphenous vein or a faulty perforating vein or veins in the thigh When the band is released a distending wave will be seen from these faulty vessels

STAGE 3 (UPPER LEG)—The veins are emptied, the band is applied immediately below the knee, it constricts both the internal and external saphenous veins The patient stands There are four possible results —

1 *Negative* If the veins of the leg remain empty for thirty seconds, the communicating veins below the band are sound

2. *Positive* If the veins reappear below the band, the leak is from a faulty perforating vein in the leg it cannot be from the internal nor the external saphenous vein for these are occluded unless the latter has a low ending (nearly 10 per cent. of cases) Frequently the incompetent perforating vein lies at the lower third of the leg on the internal surface or less often at the middle or upper calf Systematic palpation of the limb may locate this vein as a fluctuating and sensitive spot (Fig. 77)

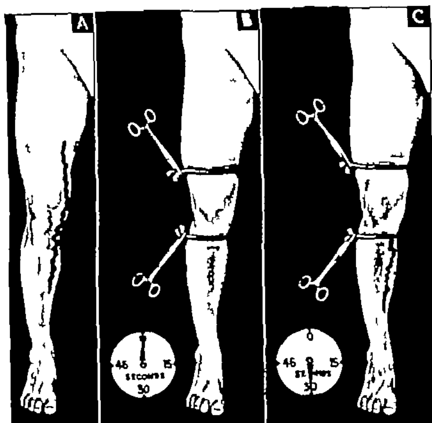


Fig. 77
The "Double" tourniquet test, indicating incompetence of a communicating vein in the leg.

3 *Positive external saphenous vein* On releasing the band if the veins fill forthwith from above downwards, and provided that the internal saphenous system and communicating veins in the thigh are already proved efficient, the external saphenous vein is at fault.

4 *Double-positive* If the veins have filled before the tourniquet is released but they distend still further (either visibly or palpably) when it is removed inefficiency of both the external and internal saphenous or communicating veins of the thigh is indicated (The state of the last two is already known from the previous tests at higher levels)

Thus it is apparent that the single tourniquet is barely adequate for a full diagnosis.

The double tourniquet test.—A double tourniquet test is used routinely for the average presentations of varicose veins, the triple tourniquet test being reserved for the extensive varicosities

The patient lies down, the limb is raised and the veins are emptied. Two tourniquets are applied, one at the groin and the other immediately below the knee, the internal and external saphenous veins are thereby controlled. The patient stands The limb is watched for thirty seconds· if no varices appear below either band, the communicating veins of the thigh and leg are efficient If varicosities do reappear and blood under pressure in them is confirmed by palpating with the fingertips, then there is a defective perforating vein below the lower band (Fig 77c) The palpation of varices is essential, the pressure of their contents can vary from nothing to considerable Some varices are thickened like india-rubber tubing and are incapable of collapsing although empty, but palpation reveals their flaccidity (Fig 78) Faulty communicating veins fill varices imperceptibly without a wave A low termination of the external saphenous veins into the veins of the calf, if inefficient, could fill the varices whilst both tourniquets are in position Palpation of the trunk of the short saphenous vein would give supplementary evidence, it would be tense and enlarged if inefficient—the percussion test would give an impulse



Fig 78
Gross varicosities from the internal saphenous vein visible although empty

Removal of the lower tourniquet.—In order to observe the main varices closely, their position may be marked previously by a skin pencil After about thirty seconds the lower tourniquet is released, taking care not to obscure the field by the hand or by crossing the light As the external saphenous vein is particularly in question, the calf of the leg will be watched (Fig. 79) A downward flow from a faulty *internal* saphenous vein is excluded by the upper tourniquet

The results may be as follows .—

1 The veins remain empty, indicating efficiency of the external saphenous vein, and of the perforating veins below the band round the upper thigh

2. The varices in the leg may fill from above downwards as the knee tourniquet is removed if so they do so from a defective short saphenous vein (Fig. 79c) or perforating vein in the thigh The varices may be distended by a slight wave grading to an obvious cascade. This is a positive response Communicating veins at the posterior border of the medial condyle of the tibia and at Hunter's canal are fairly constant and are occasionally defective and may be the source of filling

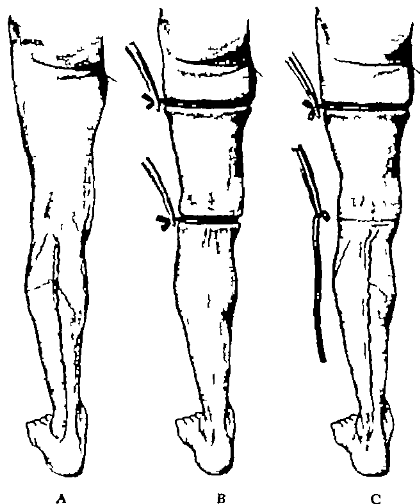


Fig. 79
The "Double" tourniquet test, indicating varicosity of the external saphenous vein.

3 The veins may reappear so slowly that it is difficult to say how the filling occurs this must be regarded as a negative result for the external saphenous vein It is often necessary to repeat the test to obtain a definite answer taking care to empty the veins fully and to apply the bands at sufficient tension As veins normally fill imperceptibly from below any obvious filling from above would suggest incompetent valves in the short saphenous system

When the external saphenous vein empties into the deep veins at the mid thigh the varices will still fill

REMOVAL OF THE UPPER BAND

1 Nothing clearly discernible may be observed, *observation,* the long saphenous vein is competent

2 Clear filling from above-downwards follows, thus the internal saphenous vein is probably varicose

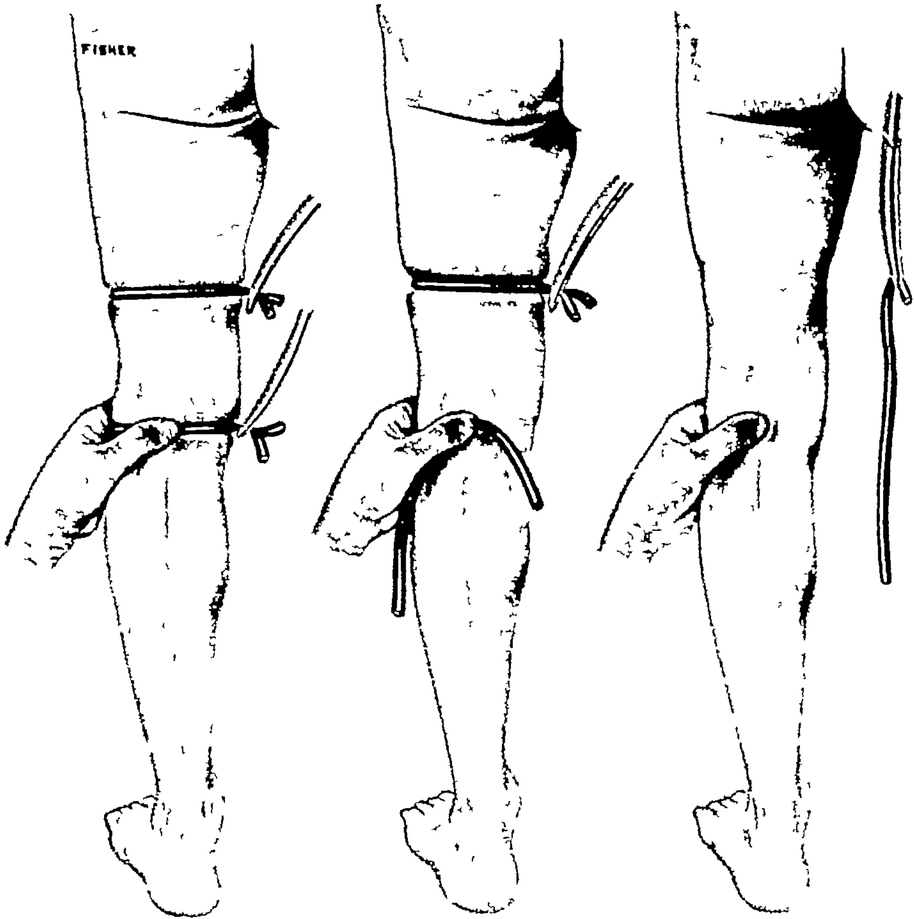


FIG 80
The procedure to exclude the external saphenous vein, whilst testing the internal saphenous vein

3 The veins of the leg and thigh fill still further and become tenser, *observation,* the internal saphenous vein is incompetent in addition to other lower defects

4 The veins fill unconvincingly; *observation,* the veins were incompletely emptied, or a small incompetent communicating vein is present The test must be repeated

FURTHER TESTING WITH THE TWO TOURNIQUETS —The tests are continued placing the upper tourniquet at the middle of the thigh, and then at the lower third (Fig 80).

MID-THIGH COMMUNICATING VEIN —The site of an incompetent mid thigh communicating vein can be pin-pointed by moving the lower tourniquet up and down the thigh and observing the level at which filling from above stops

The three tourniquet test.—*After long use the three tourniquet* test has been found to be desirable for patients with the grosser presentations of varicose veins (Fig. 81) It is little more trouble than the single or

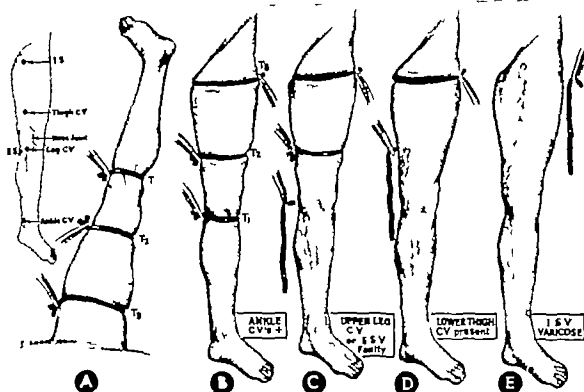


FIG. 81
The "Triple" tourniquet test.
C.V's = communicating veins. E.S.V = external saphenous vein.
I.S.V = internal saphenous vein.

double bands and saves time in those with marked veins. Cooper described the use of multiple tourniquets in 1934 The three constrictions are painful and it is not always easy for the older and obese patient to get up and stand with them thus the test is for the more difficult legs After thorough emptying of the veins the tourniquets are applied as follows —

The first band is immediately below the knee it compresses the external saphenous vein and the communicating vein at the inner border of the upper tibia The second is about the lower third of the thigh this easily falls into position for there is a slight groove on the inner surface at this level It controls the perforating vein passing into Hunter's Canal The last is immediately below the groin it controls the internal saphenous vein and those rare varices from inefficiency of the parietal tributaries of the internal iliac vein

The patient stands and the leg is inspected for thirty seconds for filling of veins which are noted The person is asked to stand a moment on the toes This powerful movement brings the calf-muscle pump into forcible action and if the ankle communicating veins are defective, varices in these areas will fill to an extent corresponding with their number and size This filling is confirmed by palpating the veins and forming an estimate of their contents



FIG 82
The triple tourniquet test and the exclusion of the external saphenous vein by digital pressure The lower band is then removed and any filling would be from an incompetent communicating vein below the thigh tourniquet

THE LOWEST TOURNIQUET.—After thirty seconds, the lowest tourniquet is removed to observe the external saphenous vein or a possible incompetent communicating vein arising at the posterior border of the inner tuberosity of the tibia or lower thigh (Fig 81c). These vessels drain different territories and are unlikely to be confused, the external saphena is the commoner defective vessel The calf is watched especially and distension of varices will suggest the inefficiency of these veins If there is obvious filling on the release of this band and its source is not clear, the patient lies down again and the bands are reapplied and the erect position is resumed The fingers are pressed over the external saphenous vein in the popliteal space (Fig 82) immediately above the lowest band, which is then removed Any filling of veins that follows is from the incompetent communicating vein at the internal tibial tuberosity If no distension follows, the fingers controlling the external saphenous vein are withdrawn and this vessel and its tributaries if defective will be seen to distend

Should there be no apparent filling on removing the knee tourniquet, then the communicating veins below the lower third of the thigh and the short saphenous vein are sound.

THE MIDDLE TOURNIQUET —The tourniquet around the lower thigh is next released and any further veins appearing would declare a faulty communicating vein between this level and the band round the upper thigh the usual faulty vessel being that passing into Hunter s canal (Fig. 81D and Fig. 41 p 54) Occasionally one goes in through the adductor muscle (Fig. 83) rectus femoris or tensor fasciae femoris (Fig. 84)



FIG. 83
A large communicating vein from the inner thigh, causing varices and an ulcer at the ankle this is unusual.

THE UPPER TOURNIQUET —Finally the highest band is released and this reveals the state of the internal saphenous vein as already described (Fig. 81E) The three tourniquets often need to be repeated before a full diagnosis is obtained

PALPATION OF INTRAVENOUS TENSION AND TOURNIQUET TEST —Sometimes in an obese patient the varices are not clearly visible and tourniquet observa tions are uncertain. For these persons palpation of the veins by the finger is of assistance. The vessels having been emptied the tourniquet is applied and the patient stands The fingers are placed lightly on the vessels being tested An estimate of their contents is made after twenty to thirty seconds

When the constriction is released, mature varicosities can be felt to distend with a downfilling and expansile wave

Sometimes the varices look full, but palpation reveals them to be flaccid, their full appearance could lead to an erroneous deduction On other occasions varices will be found to be fluctuant before the band is released and are,



FIG 84
A " blow-out " from a faulty communicating vein passing through the tensor fasciae femoris

therefore, connected with a filling source, below the tourniquet On release of the constriction a further increase of the pressure may be perceptible in the already partly filled varices In these patients the percussion test is of assistance

The Mahorner-Ochsner (1936) comparative tourniquet test (also known as Perthes' test).—This test is based on the aspirating effect of muscular action on the contents of the superficial veins, via the perforating veins When the valves of the latter are sound, they will not allow blood to regurgitate outwards and therefore superficial veins empty during exercise

PROCEDURE —The undressed patient with varicosities is inspected all round while standing and marking time A tourniquet is applied to the upper third of the leg firmly enough to compress the superficial veins The patient again marks time and the veins below the band are watched The process is repeated with the band at the lower third of the thigh and then again at its middle Throughout the observations the vessels above the constrictions are ignored One of three things may happen —

1 *The superficial veins become less prominent* —This indicates that the muscular action has sucked blood from the superficial veins through the communicating veins the valves of which are sound and prevent superficial regurgitation The varicose veins are therefore filled from a source above the tourniquet, *e g* when the band is around the leg, probably from the internal or external saphenous vein

2. The veins remain the same or become more prominent. This points to *incompetence of a communicating vein or veins below the tourniquet* Exercise normally squeezes blood out of the muscles into the deep veins but if a perforating vein or veins are defective, blood can pass both inwards and outwards during contraction As the band prevents it passing upwards by the superficial veins these become more obvious

3 If in addition the limb becomes dusky this suggests that the valves of the deep veins are ineffective or that they are possibly obstructed (*i e* thrombosed) and the additional blood needed for the exercise, unable to pass out through the superficial or deep veins, further distends them. This result could also occur if the tourniquet was tight enough to constrict normal deep veins. It is only in the frank phlegmasia alba dolens that the blood is deflected into the superficial veins and this diagnosis is obvious clinically and does not need tourniquet tests

General remarks on the tourniquet tests

1 *They need time and patience to perform*
2 *Their results are not always clear cut even in experienced hands*
3 *The simple Trendelenburg test and the percussion test are the most practicable The multiple tourniquet tests are only of use in the grosser presentations of varicose veins*
4 *In some limbs (fat swollen or with chronically ulcerated or eczematous ankles) the tourniquet tests are somewhat impracticable*

THE CLINICAL PRESENTATIONS OF VARICOSE VEINS AND THEIR DIAGNOSIS

Having reviewed the clinical diagnostic methods the characteristics of the various presentations of varicose veins will be reviewed (Figs 85 to 93) Many of these can be recognised on close inspection but they should be systematically tested we deprecate "spot" diagnosis

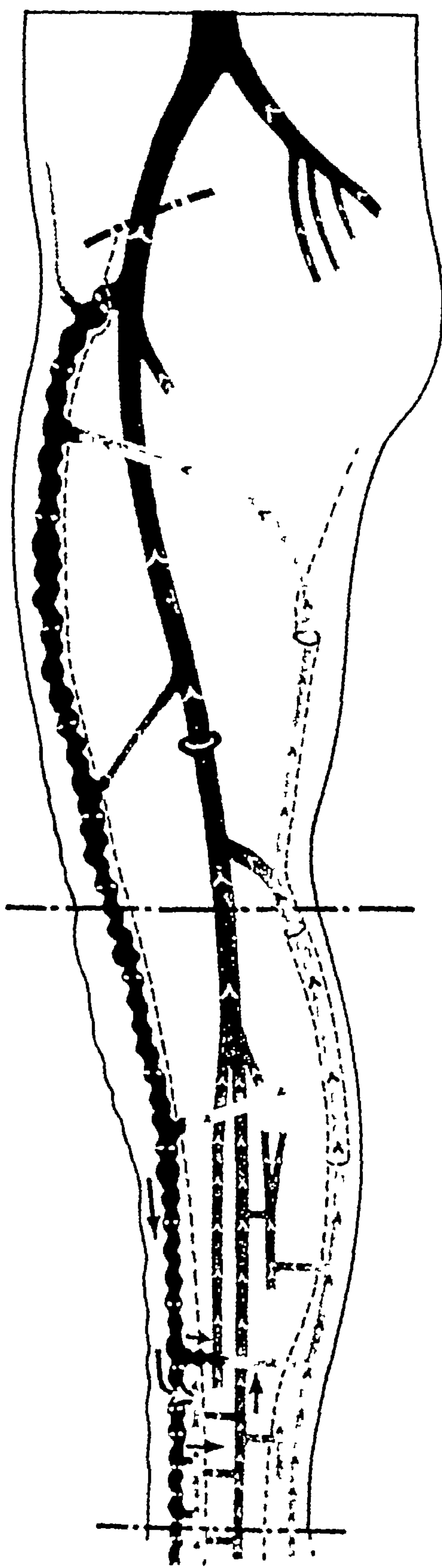


Fig 85
The varicose internal saphenous vein (diagrammatic)

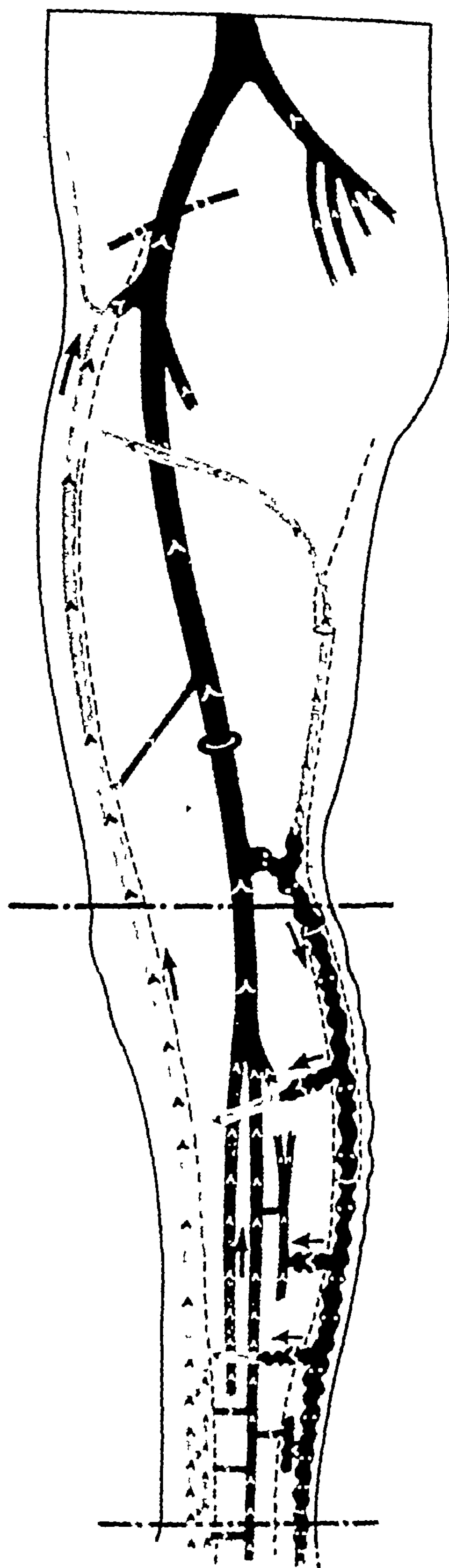


Fig 86
The varicose external saphenous vein (diagrammatic)

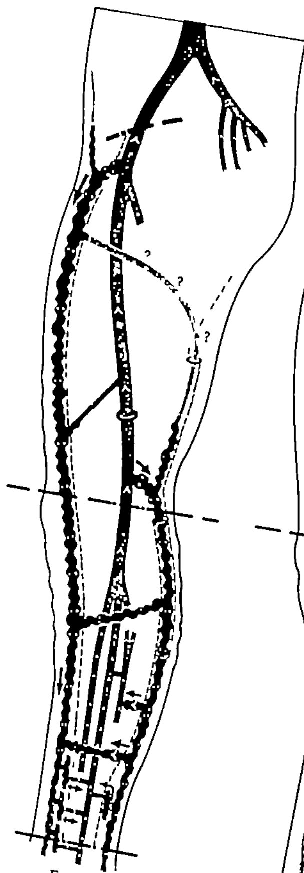


FIG 87
The combined varicosity of the internal and external saphenous veins (diagrammatic).

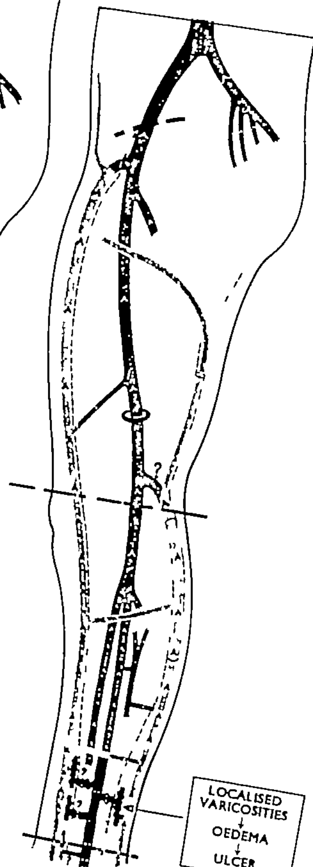


FIG. 88
The incompetent ankle communicating veins. The question marks indicate that not all those veins are necessarily incompetent at the same time (diagrammatic)

VARICOSITIES & OEDEMA OF INNER ANKLE

ULCER

Fig 89
The varicose internal saphenous vein and incompetent perforating veins (diagrammatic)

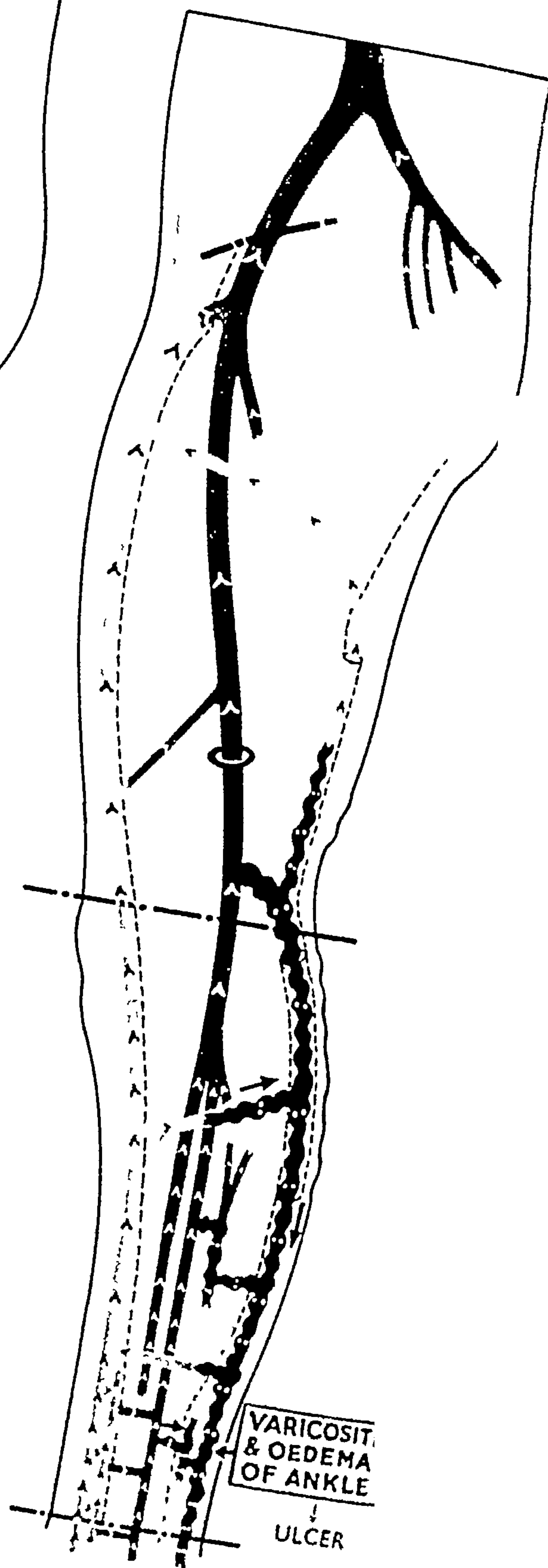


Fig 90
The varicose external saphenous vein and incompetent perforating veins (diagrammatic)

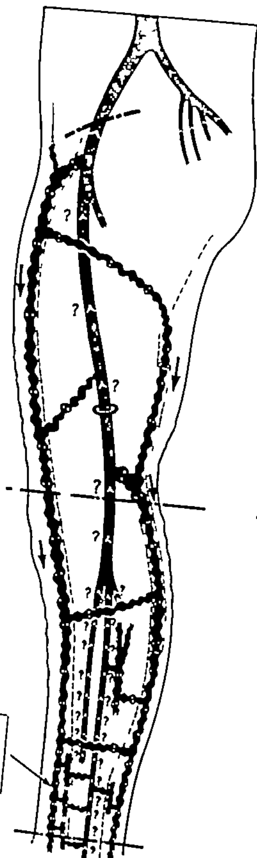


FIG. 91

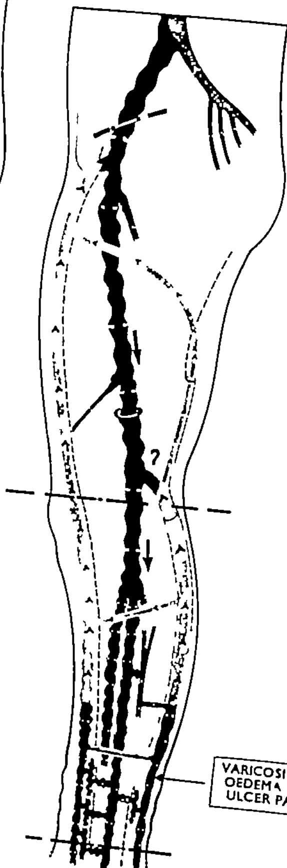


FIG. 92

FIG. 91 The triple incompetence, i.e. varicosity of the internal and external saphenous veins and defective perforating veins. The question marks indicate the variable state of the valves of the deep veins (diagrammatic).

FIG. 92. Some later effects of deep thrombo-phlebitis (diagrammatic) incompetent deep and perforating veins.

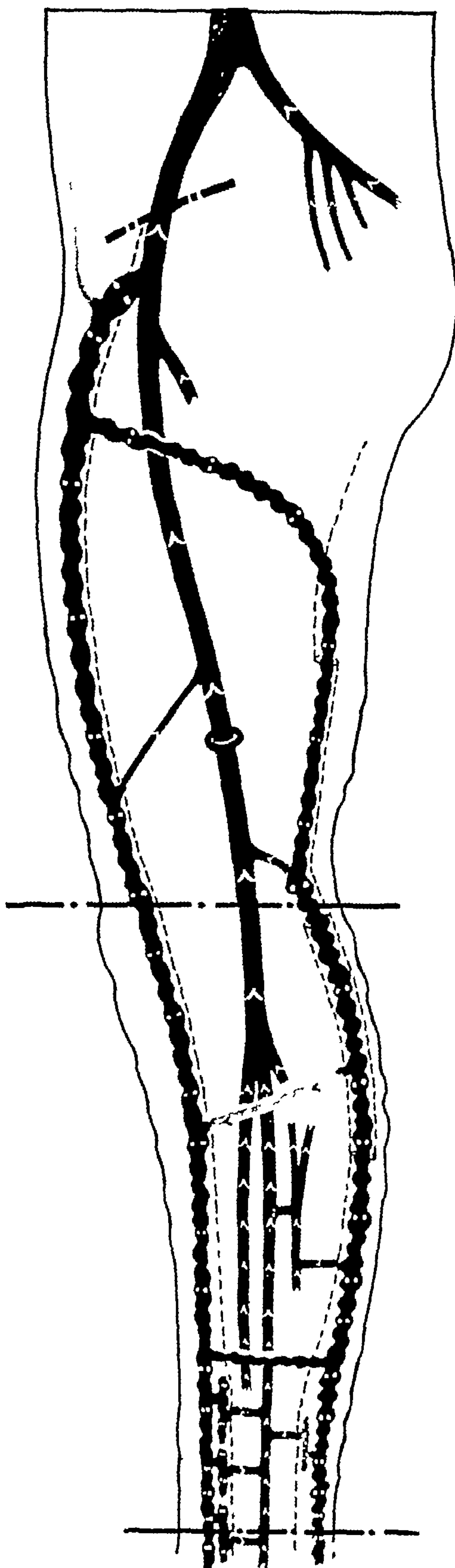


FIG 93
Varicosity of the internal saphenous vein affecting the external saphenous vein

The types of inefficient superficial veins which occur in the lower limbs are as follows —

1. Early varicose veins

A single varicose vein, a cluster or clusters of localised tortuous varices in the thigh or leg, are frequent, they vary in size at the menstrual period, in warm conditions, at the end of the day or during extra activity they may ache They are often described as "trivial," "vanity" or "nylon" veins and may overlay an incompetent perforating vein They are not clearly connected with the saphena groups which are often inconspicuous and the tests prove them to be efficient

2. The incompetent internal or long saphenous vein (Fig 85)

The signs of an internal saphenous vein whose valves are incompetent are —

1 In the event of a considerable enlargement and in a thin person, the enlarged saphenous trunk is palpable from the groin to the internal malleolus, and it may be visible, but often it is not seen The trunk may be palpable from the ankle to the knee, or to the mid-thigh, and it often disappears above these points suggesting filling from a faulty perforating vein here, but the tourniquet will usually prove that the internal saphenous vein is faulty at its termination (Fig 94)

The saphenous trunk is much stronger than its tributaries; it remains straight and distends but slowly compared to these The numerous varices visible about the course of the internal saphenous trunk are its enlarged tributaries and not, as they may suggest, the enlarged and tortuous principal vessel This fact is the basic reason why the stripping operation is possible

At the foramen ovale in the groin, the vessel may be rollable as a tense



Fig. 94



Fig. 95

Fig. 94
Varices apparently arising from an incompetent communicating vein in Hunter's canal. The *tests disproved this possibility*: they are due to an incompetent internal saphenous vein.

Fig. 95
A case of apparent simple varicosity of the internal saphenous vein, but the external saphenous is also incompetent (*see* Figs. 110 and 111).

elastic cylinder, and a saphena varix may be visible or palpable (Fig 95) It may be concealed by inguinal adenitis There may be other globular dilatations or blow-outs visible along its trunk One about the knee is frequent

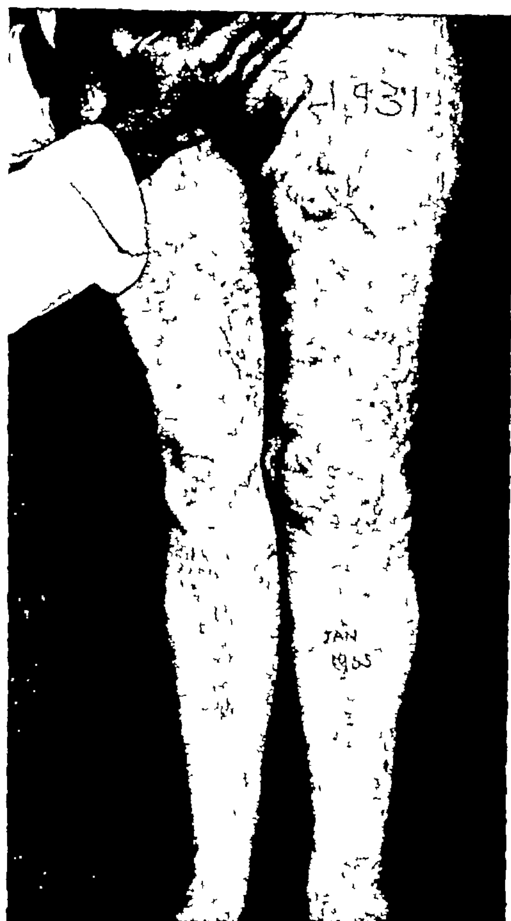


FIG 96

Recurrent varicosity of the internal saphenous vein largely affecting the antero-external vein Figure 139 illustrates the same feature

When the patient coughs, an expansile impulse or thrill in the grosser examples is palpable in the vessel trunk and its varices from the groin to the leg

The tourniquet test is positive The incompetent external saphenous vein is excluded from filling the varices by digital pressure over the sapheno-popliteal junction after the veins have been emptied, so that the backflow can only be from the internal saphenous or a defective perforating vein (*see* Fig 80)

Its principal tributaries, the antero-external (Fig 96) or the postero internal veins in the thigh (Figs 97 and 98) may be grossly varicose, whilst the main trunk may appear to be unaffected. Likewise the anterior vein of the leg (Fig 99) and posterior arch vein (Figs 100 and 102) in the inner calf may be prominent The varices on the outer leg might suggest incompetence of the external saphenous vein, but the tests will determine this Varices in the upper and inner thigh and in the labia suggest varicosity of the superficial external pudic vein, possibly the residue of a former deep phlebitis or varicosity of a perineal tributary of the internal iliac vein These unusual presentations emphasise the need for an open mind and systematic examination (Fig 101)

The percussion test from the ankle or knee to the groin and vice versa is positive

In a faulty internal saphenous vein any blood aspirated from the varices of the limb through efficient perforating veins is immediately replaced from above and walking does not entirely relieve the back pressure A " private "



FIG. 97



FIG. 98

FIGS. 97 and 98
Varicosity of the postero-internal tributary of internal saphenous vein.



FIG. 99

FIG. 99
Bilateral internal saphenous incompetence with marked varicosity of the anterior tributary in the left leg.



FIG 100
Varicosity of the posterior arch vein of the leg

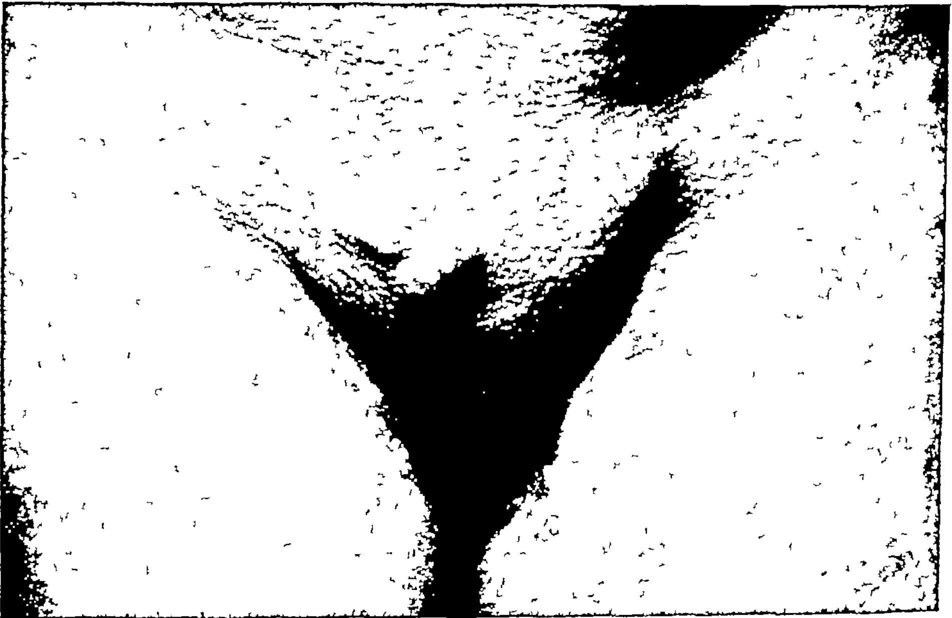


FIG 101
Pubic varices from incompetence of the superficial external pudic vein, part of incompetence of left internal saphenous vein, a remnant of a former deep thrombo-phlebitis

A B

Fig. 102

Gross internal saphenous incompetence but with good ankle skin. A, B and C.

circulation is in existence down the long saphenous vein then through the perforating veins (especially those above the ankle) into the deep veins.

The incompetent internal saphenous vein is by far the commonest varicose presentation

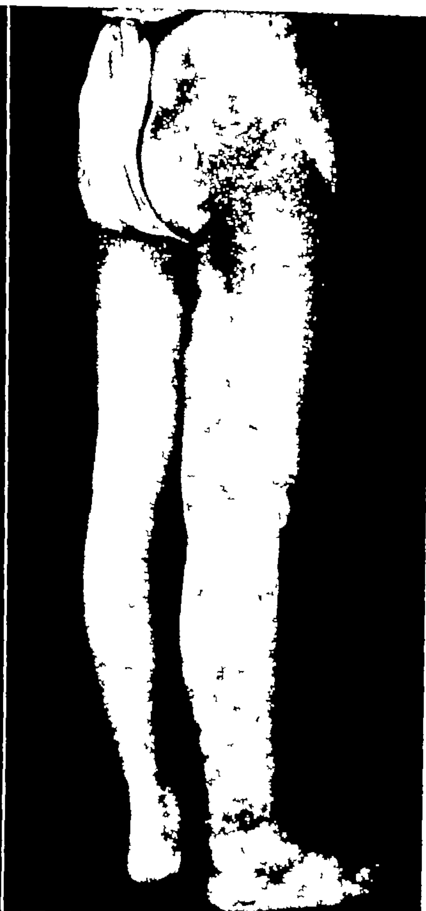
Symptomless or morbid varicosity of the long saphenous vein.—Patients with internal saphenous varices fall into two classes. There are those with *obvious incompetence* and who suffer no discomfort beyond the unsightliness of the large vessels. They are active and it is significant that their ankles are



C



A



B



C



D



E

FIG 103

Congenital venous abnormality of the right leg showing extensive skin staining and a difference in the length and girth of the limb This suggests the possibility of arterio-venous fistulae (congenital)

shapely and that there is no deterioration of the skin about the foot, ankle leg (Figs 97 and 102) Unusual skin changes are occasionally seen on thigh and leg in young people the possibility of an arterio-venous fistu must then be considered in these (Fig. 103)



FIG. 104
Varicose internal and external saphenous veins with gross skin changes at the ankle

By contrast there are patients with similar degrees of internal saphen varicosity but whose legs, ankles and feet are manifestly in poor condit with degrees of discomfort, disability swelling, pigmentation eczema ulceration (Fig. 104) These contrasting conditions occur at all ages believe that they often result from combined inefficiency of the ankle c

municating veins and the internal saphenous vein, thus there is a double source of venous hypertension (*see* Chapter XIV)

The varicose external or short saphenous vein (Fig 86)

This vein drops like a plumb-line from the middle of the popliteal space to the outer border of the tendo-Achillis and passes behind and below the



FIG 105
Bilateral varicosity of the external saphenous vein, the same patient as Figure 104

external malleolus (Fig 105) Even when varicose, the trunk is not obvious except in the thin person, as it is better supported and concealed by aponeurosis than the long saphenous vein This is one reason why its diagnosis is often overlooked It usually causes varicosities about the centre and outer



FIG. 106 FIG 107

FIGS. 106 and 107

A varicose external saphenous vein, complicated by an unusually situated ulcer of the calf

aspect of the calf and the external malleolus the hollow behind the latter is often partly or completely filled by oedema and varices It may fill vessels on the inner surface of the leg through the connecting veins with the internal saphenous system (Figs 108 and 109) A faulty short saphenous vein can enlarge the veins in the lower third of the thigh, whilst the great saphenous vessel is sound. Both the internal and external saphenous vessels anastomose freely especially above the ankle and below the knee these connections may be defective and give varicose veins in the territory of a system which has a sound terminal valve The external saphenous vein is varicose only one-tenth as often as the internal saphenous vein whilst even less frequent is incom



FIG 108 FIG 109

FIGS 108 and 109

A varicose external saphenous vein causing varicosities and eczema on the inner leg In Figure 109 the thumb is occluding the termination of the external saphenous vein after emptying it

petence of the long and the short saphenous veins in the same limb (Figs 110 to 112) Varicosity of the internal saphena in one limb and of the external saphena in the other is quite common, it is a diagnosis which adds piquancy to the examination of a patient with bilateral varices (Figs 113 to 116)

The distended enlarged trunk of the external saphenous vein is only visible in some patients, but is usually palpable throughout its course from behind the external malleolus to the popliteal space In some it is felt more easily when the examiner is in front of the patient Palpation is the most important method of detecting its possible incompetence



Fig. 110

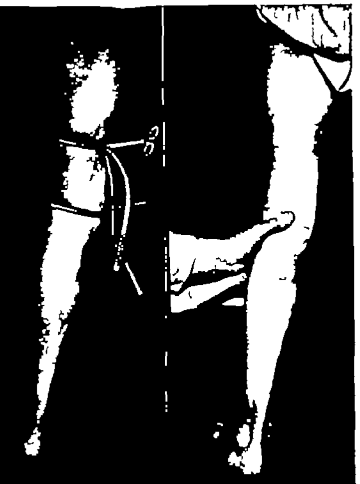


Fig. 111

Figs. 110 and 111

(*a*) A varicose left internal saphenous. (*b*) A varicose right external saphenous, the differential test.

Fig. 110 shows the varices distended by the external saphenous vein while the long saphenous vein is excluded by a thigh tourniquet

Fig 111 shows the varices still filled by the long saphenous vein while the short saphenous vein is controlled by thumb pressure.



FIG 108 FIG 109

FIGS 108 and 109

A varicose external saphenous vein causing varicosities and eczema on the inner leg In Figure 109 the thumb is occluding the termination of the external saphenous vein after emptying it

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Fig. 110

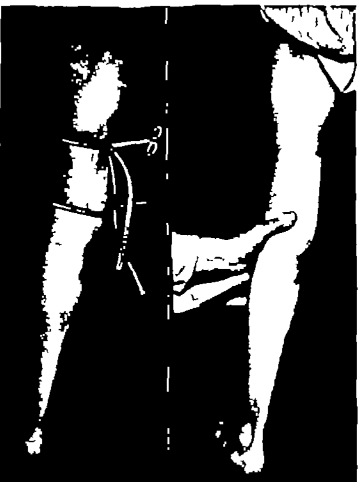


Fig. 111

Figs. 110 and 111

(*a*) A varicose left internal saphenous. (*b*) A varicose right external saphenous, the differential test

Fig. 110 shows the varices distended by the external saphenous vein while the long saphenous vein is excluded by a thigh tourniquet

Fig. 111 shows the varices still filled by the long saphenous vein while the short saphenous vein is controlled by thumb pressure.

Over sixty per cent of the external saphenous veins join the popliteal vein behind the knee one to three inches above the level of the joint line (Kosinski, 1926) As approximately the last portion of the vein lies under the deep fascia of the popliteal space, this part is inconspicuous, but when it is clearly varicose, it is occasionally visible and usually palpable by the finger



FIG 112
Combined varicosity of the internal and external saphenous vein in the same limb Before and after operation

tips as an elastic cylinder, until it dips deeply into the popliteal space to join the popliteal vein In fat feminine calves, the vessel is concealed and may be completely missed

Gross incompetence of the external saphenous vein does not necessarily indicate that the valves in the femoral and popliteal veins are inefficient

The " cough impulse " in external saphenous vein incompetence is rarely present This sign could mean the incompetence of the valves in the popliteal

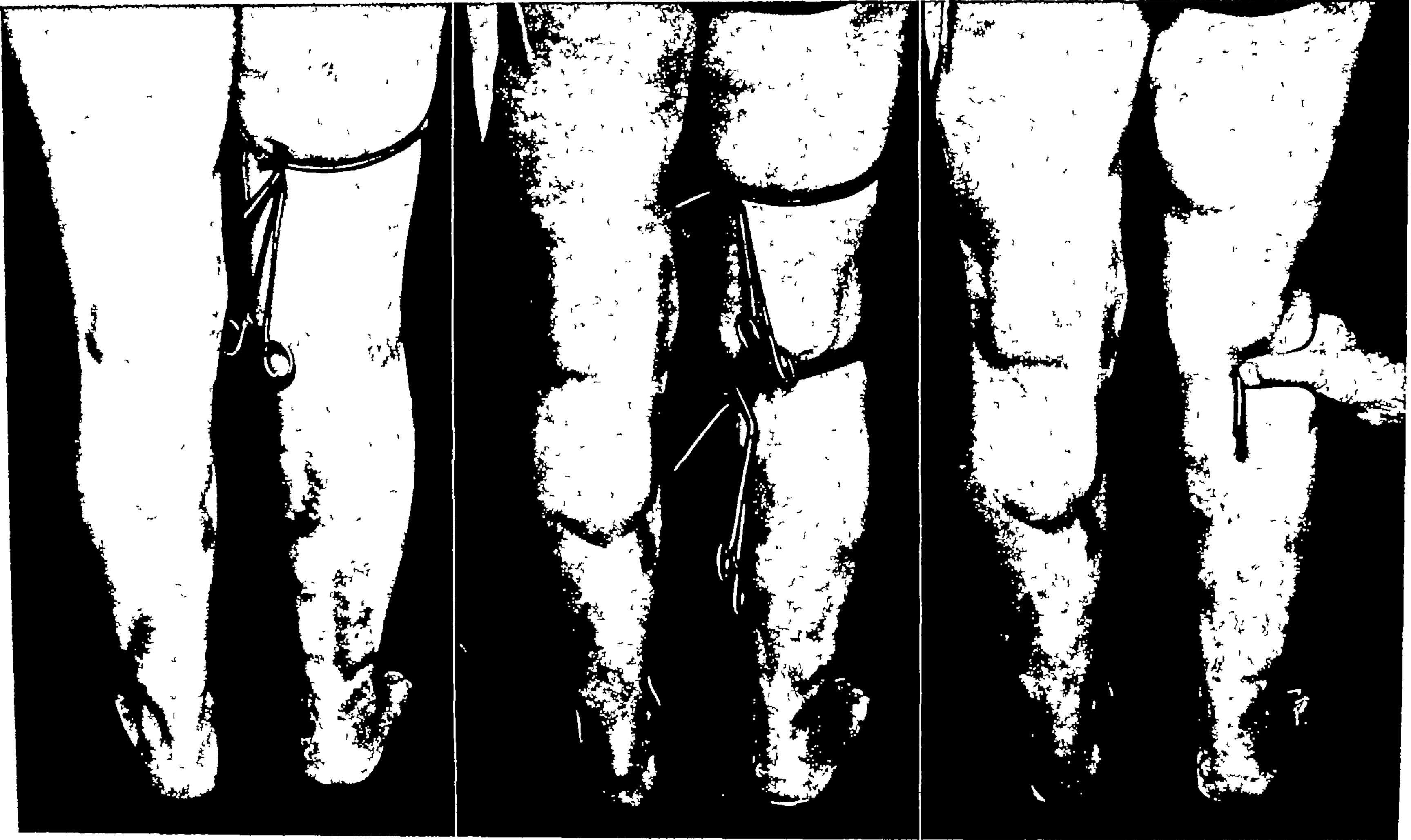


FIG. 113
The left internal saphenous is incompetent (veins painted with iodine) The short saphenous is defective (right).

and femoral veins, but a cough impulse may also occur in the varicose external saphenous vein when it is connected to an inefficient internal saphenous vein through the latter s postero-internal tributary

The double tourniquet test is positive *i e* when one band is around the thigh and another around the knee and the latter is removed a down filling wave promptly fills the varices (Figs 117 and 118)

On the contrary when the varices are emptied and the termination of the incompetent external saphenous vein is controlled by digital pressure (Fig. 114c) and if the internal saphenous and communicating veins are sound then although both tourniquets are removed the varices will remain empty Filling of the varices immediately follows the release of the short saphenous vein. In external saphenous incompetence discomfort is occasionally felt in the back of the thigh and buttock



A B C

FIG 114

Varicosity of the external saphenous vein in the right limb A shows the veins still full while the long saphenous vein is excluded B shows the internal and external saphenous veins excluded by bands C shows that the veins are controlled by exclusion of the short saphenous vein only the long saphenous vein is free but *being competent does not fill the varices*

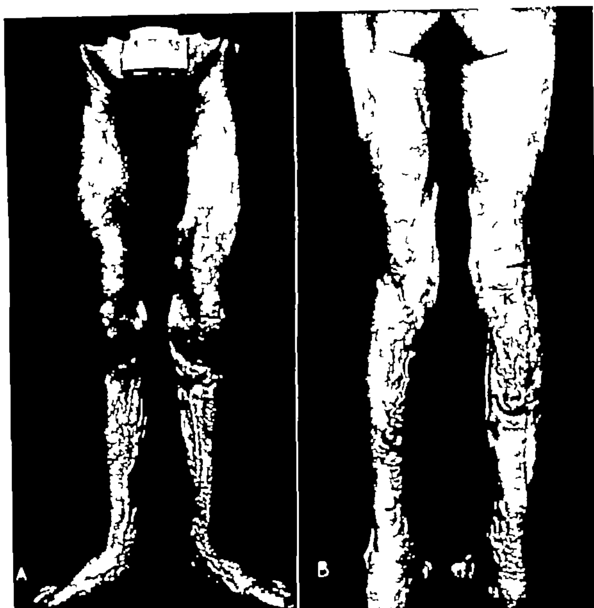


FIG. 115

A varicose right external saphenous and varicose left internal saphenous vein. Superficially these legs are alike and a "spot" diagnosis would probably have been wrong. A. Front view notice the left saphena varix and left varicocele. B. Rear view note the level of the knee joint (K.J.) and the point where the external saphenous dips down into the popliteal space (right leg). *See* Fig. 116.



FIG 116

C The veins have been emptied, a tourniquet applied round the right thigh and knee, the latter has been replaced by thumb pressure over the end of the external saphenous vein D The upper tourniquet has been removed, and the veins remain empty by the thumb pressure only, so proving that the varices arise from incompetence of the short saphenous vein Note the small internal malleolar ulcer on this limb



FIG. 117 FIG. 118

FIGS. 117 and 118

The varicose external saphenous vein diagnosed by the two tourniquet tests.

The external saphenous vein resembles the internal saphenous in that it can be grossly varicose without symptoms or skin changes about the ankle whilst other patients will show pre-ulcerous skin changes or ulceration Here again the defective communicating veins about the ankle are often the additional destructive factor

Figures 119 and 120 show a somewhat unusual external saphenous varicosity

The percussion test.—This is positive in the varicose external saphenous vein from the popliteal space to the ankle and vice versa

We would emphasise that varicosity of the short saphenous vein is in our experience frequently overlooked it must be looked and felt for and the tourniquet test performed to avoid this mistake

Pseudo-external saphenous incompetence.—A collection of varices in the lower fourth of the thigh, popliteal space and upper leg mainly on the outer aspect will give the signs of external saphenous incompetence inasmuch as

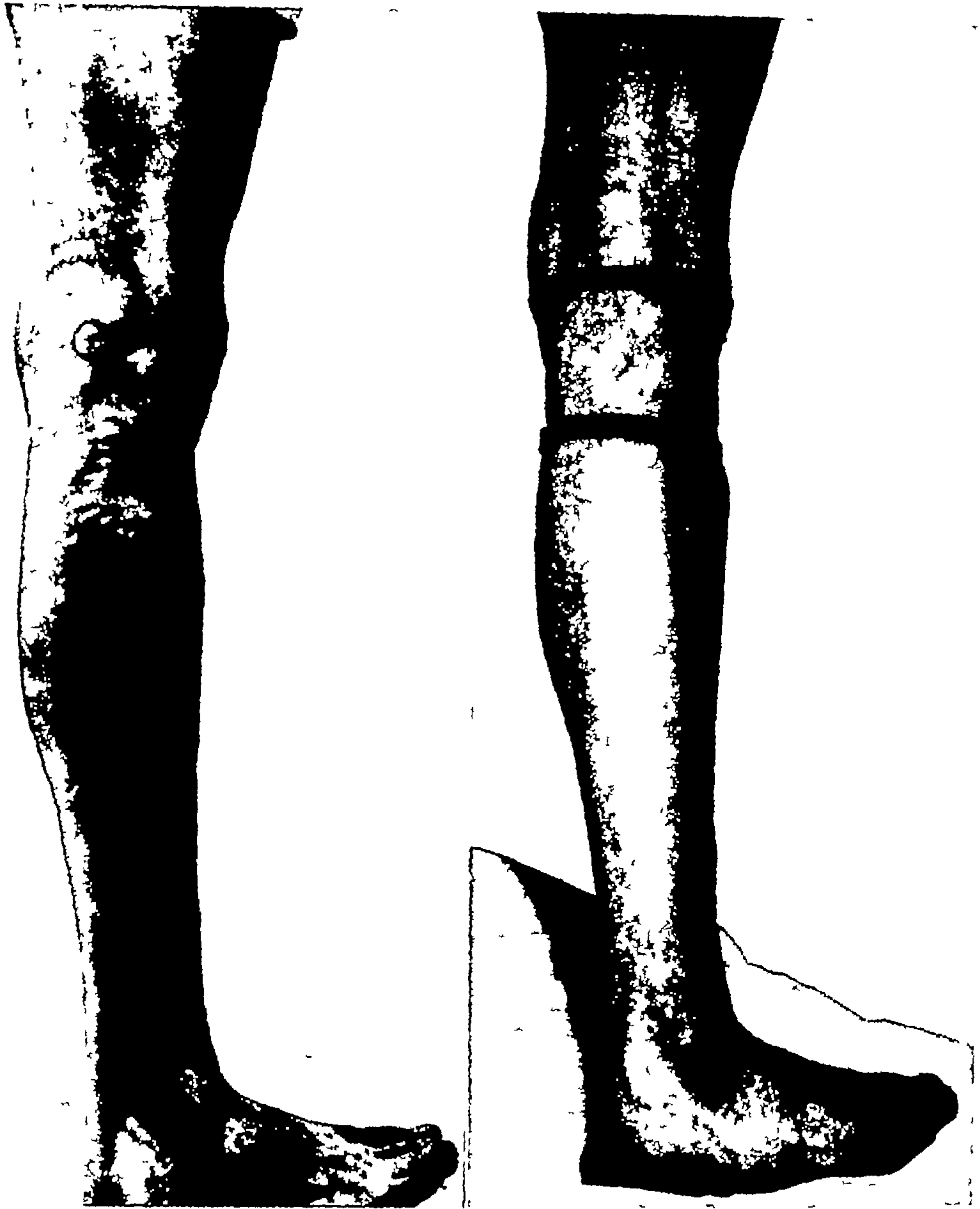


FIG 119 FIGS 119 and 120 FIG 120
A somewhat unusual presentation of the varicose external saphenous vein with a localised cluster of varices in the upper and outer surface of the leg

pressure over the centre of the popliteal space after emptying, maintains them collapsed and they fill immediately the occlusion is released

Whilst these varices are occasionally filled from the external or internal saphenous vein, they are at times fed by a large faulty vein which penetrates the popliteal fascia and winds through the lateral part of the popliteal space to join the outer side of the popliteal vein Sometimes the vessel joins veins in the semi-membranosus muscle (or biceps) At operation the external saphenous vein may be seen to be normal in the centre of the popliteal space. The exposure of course is planned to include a sapheno-popliteal ligation if necessary (*see* later how to test a vein suspected of inefficiency at operation)

Internal and external saphenous vein incompetence differentiated— Varicose veins *in the leg* only and not in the thigh may be due to a defect in a perforating vein in the internal or external saphenous vein or to a combination of these The differentiation is as follows —

The state of the perforating veins in the thigh and leg and of the external saphenous vein is already known from the two or three tourniquet test. The question remaining is, what is the efficiency of the internal saphenous vein is it filling the leg varices? The external saphenous vein must be excluded to answer this (*see* Figs 115 and 116)

The varices are emptied and the tourniquets are reapplied to the upper thigh and knee The patient stands. The observer precisely controls the short saphenous vein by pressing the thumb over it just above the centre of the transverse crease behind the knee and then the lower band at the knee is removed (Fig 116) This step prevents filling of the varices from the external saphenous vein but will allow filling from the internal saphenous when the upper thigh tourniquet holding any backflow from it is released. If the leg varices dilate from above-downwards while the digital pressure is excluding the small saphenous vein then the internal saphenous vein must be defective (Figs 110 and 111) If there is no change in the varicosities the long saphenous and perforating veins of the thigh are sound (Figs 113 114 and 116) Release of the thumb will with an inefficient short saphenous vein fill the varices promptly

The results vary from being clear cut to doubtful and they often require repetition. The variable tension of the tourniquets and partial preliminary emptying of the veins will sometimes cause this Some degree of internal saphenous fault is often present in many defective short saphenous and perforating veins. Bearing in mind that in about 30 per cent. of cases the short saphenous vein empties into the long saphena, either in the thigh or calf this is not surprising.

When the test is done and the filling is not obvious enough for a firm decision palpation of the varicosities during and after release of the band will sometimes confirm that they have become more tense, indicating retrograde venous flow The percussion test will also assist, especially if the patient is asked to blow with the mouth closed.

If they continue inconclusive a *phlebogram* will throw additional light on the problem (Chap XIII)

4 Simultaneous incompetence of the internal and external saphenous veins (Fig. 87)

Two primary diagnoses have been described *i e* incompetence of the internal and external saphenous systems They may occur together in the same limb (Figs 111 112 and 121 to 124)



FIG 121



FIG 122

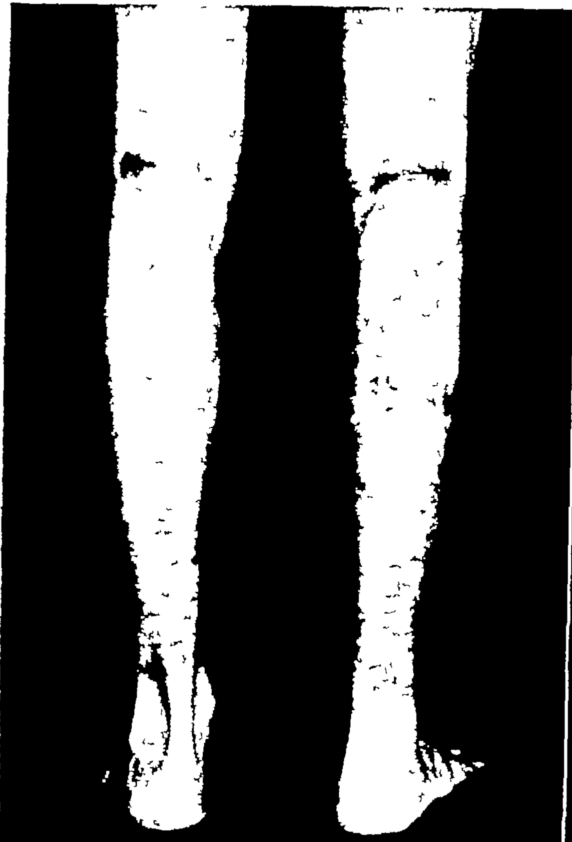


FIG 123



FIG 124

FIGS 121 122 123 and 124

A case of combined internal and external saphenous varicosity (right) showing Fig 121, bilateral external saphenous varicosity Fig 122 an unusual patch of eczema below the inner knee Fig 123 the calves after operation Fig 124 the right limb after operation, and disappearance of the eczema Note the scars terminal ligation and stripping of the saphenous trunks was performed

The diagnosis of simultaneous incompetence of the internal and external saphenous veins has been outlined by the specific tourniquet tests. It is associated with extensive varicosis in the thigh leg and ankle The main trunks of these two vessels may be seen or felt to be distended throughout their



FIG. 125 FIG. 126 FIG. 127

FIGS. 125 126 and 127

Showing recurrent varicose veins due to an undiagnosed external saphenous vein. The internal saphenous vein has already been tied and stripped. Notice also the probable incompetent ankle perforating vein and pre-ulcerous skin changes.

course and this is suggestive of their varicosity On coughing there will probably be an impulse in the internal although rarely in the external The tributaries of one system may be filled by the incompetence of the other especially the external from the internal saphena whilst the former has an efficient terminal valve The possible " high " termination of the short saphena is kept in mind (Fig. 94) The short saphena can fill some of the varices when the long saphena is excluded and vice versa The frequent mistake is to

overlook the short saphenous incompetence, because it is less conspicuous and not varicose so frequently (Figs 125 to 127)



FIG 128

Showing a "blow-out" close to an incompetent upper ankle communicating vein following deep thrombo-phlebitis which complicated haemorrhoidectomy twelve years before The "ankle flare" of ankle perforating vein incompetence is dotted on the ankle (*see* Chap XV)

5. Incompetent perforating veins (Fig 88)

Incompetent perforating veins allow blood to flow outwards from the deep to superficial veins instead of only inwards They occur alone or in combination with defects in the saphenous systems

With an incompetent perforating vein only, because there is no downward filling from the saphenous veins during walking, some of its contents are removed through these systems and other competent perforating veins,

and there may not be the same feeling of weight as when an internal or external saphenous vein is inefficient but it is their number and size which determines the signs and symptoms. Further the deep veins are usually damaged to some degree and these add their quota to the patient s discomfort.

INSPECTION —Incompetent perforating veins are suggested by "blow outs" (Figs 83 84 128 and 131) *i.e* spherical dilatations on veins under the skin of the thigh or leg A localised cluster of tortuous subcutaneous varicose veins will hint at it as will also a shower of cuticular naevoid-like dilated varicules with a vague mass of varices palpable in the fat beneath The skin is often blotchy and pigmented especially when the veins are in the lower leg.

THE TOURNIQUETS —On testing with tourniquets placed to exclude the internal and external saphenous veins, varices from incompetent perforating veins fill appreciably in about thirty seconds, especially if the patient is asked to stand on the toes once or twice thus causing the muscles to eject the blood through the incompetent perforating veins On palpating the limb after emptying the veins, a tender hole in the deep fascia may be detected. If the faulty perforating vessel is single pressure on this spot will prevent the varices from filling, whilst its release distends them

In one case of a gross defective perforating vein in the thigh when the pressure over it was released blood was felt pouring through it like water from a tap into the varices below but this is exceptional (Fig. 84) It is not often that a convincing example of this digital control test is found because there is often more than one vein at fault. Further this pressure could occlude a defective saphenous trunk too

The common pathological perforating veins are situated at the middle third of the inner thigh over Hunter s canal (Figs 81D 83 40 and 41) the upper medial aspect of the leg and especially the lower inner third of the leg These defective perforating veins are associated with varying degrees of deep vein failure the history and physical signs will suggest this in some cases but there are undoubtedly patients with deep venous failure who deny anything resembling an attack of deep thrombo-phlebitis. We have to accept in such persons that the deep thrombo-phlebitis was silent (*i.e* phlebo-thrombosis) or that the deep vein valves are defective either congenitally or have become so during life

We have sectioned over fifty incompetent communicating veins Almost all of them showed gross changes in the intima muscularis adventitia and perivenous tissues.

The following is a typical report on ligation of incompetent ankle communicating veins —

Fig. 129

Fig. 130

Figs. 129 and 130

Fig. 129, ulcerated ankles of thirty years' standing, due to varicosity of the external saphenous veins and incompetent ankle communicating veins. Note the obliterated ankle grooves. The crosses indicate tender dimples outside of the tendo-Achillis where the lateral communicating vein is incompetent and duplicated. Fig. 130 after operation; he can now stand on his toes although his tarsal joints are permanently ankylosed.

Man aged 66	*February 1955*
Lateral communicating vein	Obliteration apparently due to hyptertrophy of media.
Lower communicating vein	Great thickening of walls with enormous hyaline thrombosis.
Middle communicating vein	Lumen largely obliterated by cushion of fibrous tissue growing in from media
Upper communicating vein	Similar to lower communicating vein.

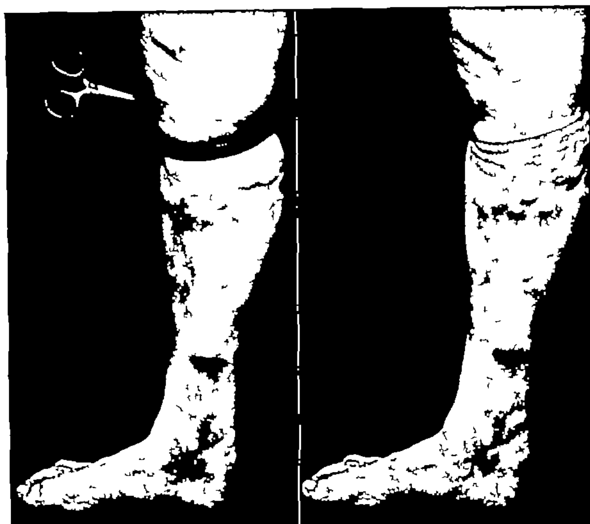


FIG. 131
An incompetent upper ankle communicating vein with an overlying varix. The " blow-out " fills after the veins have been emptied and a tourniquet applied. The varices in the upper leg are filled from this incompetent perforating vein. Tests for the long and short saphenous veins were negative It will be noticed that this patient has as yet few skin changes at the ankle only a little skin speckling and the beginning of filling of the retro-malleolar groove

Signs of incompetent " ankle " perforating veins (Fig. 88) —The frequent presence of incompetent perforating veins above the malleoli has been pointed

out by Cockett and Jones (1953) Ordinarily they are not visible on inspection Their presentation depends on their degree of development, when they are seen When established, they cause a mass of varices during standing either visible or palpable behind the lower fourth of the tibia and fibula and ankle The skin here is dusky and contains many tiny dilated varicules The grooves ordinarily present behind and below the internal and external malleoli are obliterated by oedema and dilated tortuous veins (Figs 129 and 130) Occasionally a varix or blow-out develops over one of these communicating veins (Fig 131).

These ankle varices persist after an efficient surgical elimination of an incompetent long or short saphenous system The pre-ulceration features of oedema, duskiness, pain, induration, and pigmentation of the lower third of the leg and ankle are present

Ulceration and eczema are frequent, either threatened, present, healed or recurrent

The posterior arch tributary of the internal saphenous vein starting at the internal malleolus and joining at the knee is often prominent and varicose, it can, of course, be distended by filling from a varicose internal saphenous vein (Fig 100) as well as from these defective perforating veins, or both

In some cases, the incompetent perforating vein which is the root of the trouble cannot be seen or felt, because it is covered by scar tissue or a plaque of indurated, sometimes reddened tissue consisting of fibro-fatty tissue honeycombed with distended veins These structures are occasionally the seat of fat necrosis or superficial thrombo-phlebitis

There are four perforating veins that may be defective in the lower leg

THE INTERNAL ANKLE PERFORATING VEINS (*see* Chap III) —There are usually three, they lie on a line 1 cm behind and parallel to the posterior border of the lower third of the tibia They are approximately two, four, and six inches above the tip of the internal malleolus. Their pits are sometimes palpable but insensitive in a normal leg but when pathological they are tender on pressure, probably due to former phlebitis They are tensely fluctuant whilst the patient stands Usually one or two of the three are defective

THE LATERAL PERFORATING ANKLE VEIN is five to seven inches above the tip of the external malleolus at the outer border of the tendo-Achillis (Figs 129 and 263) and is also tender on pressure when it is incompetent A distended vein may be apparent running over the tendo-Achillis connecting it to the inner ankle veins When incompetent it is surrounded by varices, oedema and skin changes The gutter behind the external malleolus is obliterated when it is well developed The lower part of the external saphenous vein is prominently dilated ; this vessel is fairly frequently varicose too

If an obese or swollen leg is raised vertically and palpated, the empty tracks of varicose veins sometimes not visible are readily felt The point where they stop or disappear may be the site of penetration of the deep fascia

by a perforating vein The sign is not absolute for a similar hole is made in the fat by a "blow-out" on a varicose vein but it is not usually tender

We sought for an explanation of their tenderness. In no case was nerve tissue found In most, the evidence indicated previous thrombosis, sometimes recent and at others old. We think that the sensitivity of these faulty perforating vessels to pressure can be explained by this former thrombo-phlebitis and their state of constant over-distension to which they are subjected, subsequent to their recanalisation

6 Simultaneous incompetence of the long saphenous and perforating veins (Fig 89)

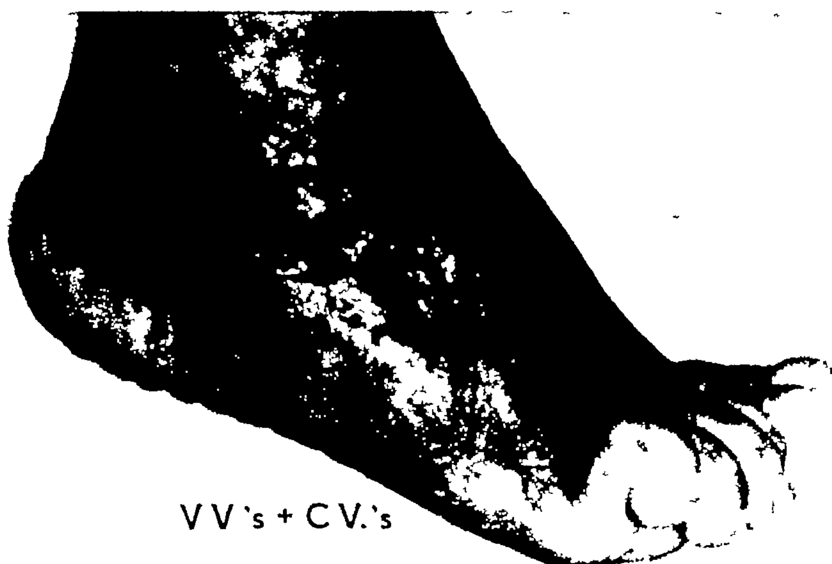
In this combination the appropriate tourniquet tests give negative results when applied to the external saphenous vein and positive reactions for the internal saphenous and perforating veins in the leg or thigh. Inefficient perforating veins at the lower third of the leg are common, but less often of the upper third Occasionally the perforating vein at the lower third of the thigh is defective The discomfort is worse on standing and is not relieved by walking. This type develops oedema skin changes and later ulceration and eczema

7 *Simultaneous* incompetence of the short saphenous and perforating veins (Fig. 90)

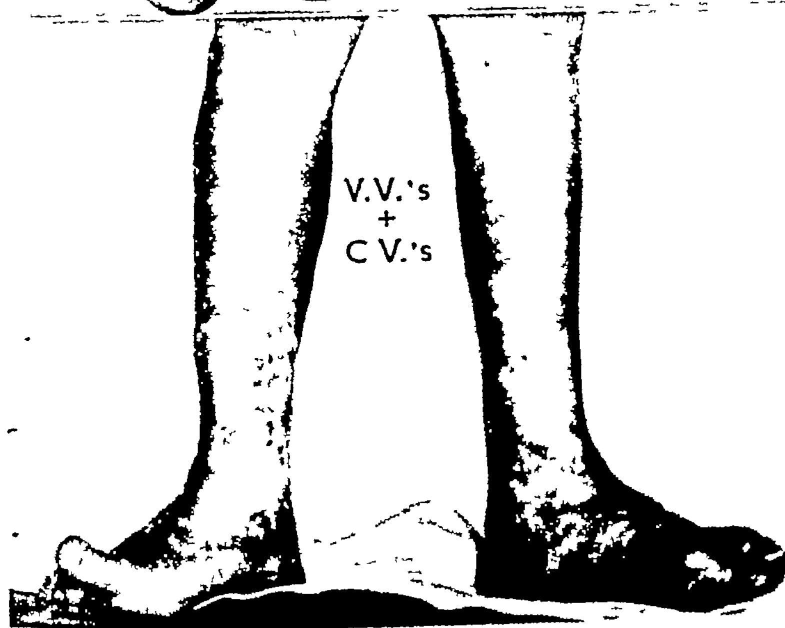
Simultaneous incompetence of the external saphenous and a perforating vein or veins is detected by the tests with two constricting bands around the lower thigh and upper leg described for these veins, and by finding pathological results in respect of each The varices occur mainly in the outer leg, but they may be found in the inner calf and somewhat unexpectedly in the lower third of the thigh, suggesting a faulty internal saphenous vein The internal saphenous vein will not be palpable throughout its course there will be no impulse in it on coughing, no varix on it, and the tourniquet and percussion tests for it will be negative.

Probably the most significant perforating vein which may become inefficient in association with a varicose external saphenous vein is the lateral one already described, five to seven inches above the external malleolar tip (Fig. 32) With this combination of external saphenous and perforating vein incompetence ankle ulceration is frequent (Figs 132, 133 and 134)

Warwick (1931) says that the main upper perforator of the short saphenous vein usually communicates with the medial upper gastrocnemial vein. Our experience is in accord with this In the upper (muscular) part of the calf the perforating veins are indirect, *i.e* they connect with muscular veins from which veins pass to the posterior tibial or popliteal veins Such a vessel when incompetent is usually associated with an incompetent muscular vein and an aching bursting pain in the calf occurs during walking and standing







Figs 132, 133 and 134

Skin changes at the ankle and exceptional ulceration of the dorsum of the foot due to varicosity of the external saphenous veins and incompetent ankle communicating veins

8. Triple incompetence, *i e* of internal and external saphenous and perforating veins (Fig. 91)

This triple combination is rare and a limb with gross varicosities can be expected Myers and Janes (1955) write of these extensive presentations. It is revealed by applying the three tourniquet test " at the groin lower third of the thigh and knee levels (Figs 135 136 137 138)

When the patient stands with the bands in position some of the varicosities in the thigh or leg or both will distend within thirty seconds especially after the patient has stood on the toes thereby exercising the calf muscle pump—thus establishing defective perforating veins of the thigh leg, or both Palpation of these prominent veins will reveal that they are filled with some tension On systematic palpation of the deep fascia by the fingertips the tender opening or openings through which they pass may be felt this search is made when the patient is standing and also lying down with the leg raised The control of filling of the varices by pressure on the suspected point by the fingertip will supply contributory evidence

THE EXTERNAL SAPHENOUS INCOMPETENCE —If when the lower tourniquet is removed obvious downward distension of the veins occurs then the external saphenous is incompetent It may be necessary to re apply the tourniquets and to release the lowest as soon as the patient stands, in order to be sure that a distension wave does descend from the external saphenous vein before the filling from a defective communicating vein obscures the picture.

THE INTERNAL SAPHENOUS INEFFICIENCY —The bands are re-applied, the external saphenous vein is excluded by pressure of the thumb on its ending before the lowest tourniquet is removed the second one is released and some filling of the veins by an inefficient perforator of the thigh usually at Hunter s canal may be apparent. Lastly the upper band is detached and with a triple defect, a downward wave of distension will indicate a diseased internal saphenous system

This triple fault is often associated with defective deep veins (*see* Chap XIV)

9 Internal iliac vein inefficiency

A rarer type of varicosity occurs in the veins of the upper and posterior surface of the thigh which empty into the internal iliac veins These tributaries comprise the sciatic gluteal pudendal and obturator veins and they may take part in the general varicosity of the superficial veins of the lower limbs (Fig. 139) Unless their incompetence is considered a complete diagnosis is unlikely The volume of blood carried by the internal iliac system is larger than is generally realised

Varices of these veins are prone to appear in patches over the back of the upper thigh perineum, genitalia popliteal space and calf The last two suggest inefficiency of the external saphenous vein but the tourniquet tests will demonstrate its efficiency A characteristic of internal iliac varices especially during pregnancy is that of purple naevoid patches on the skin of the

FIG 135





FIG 136

FIG 137

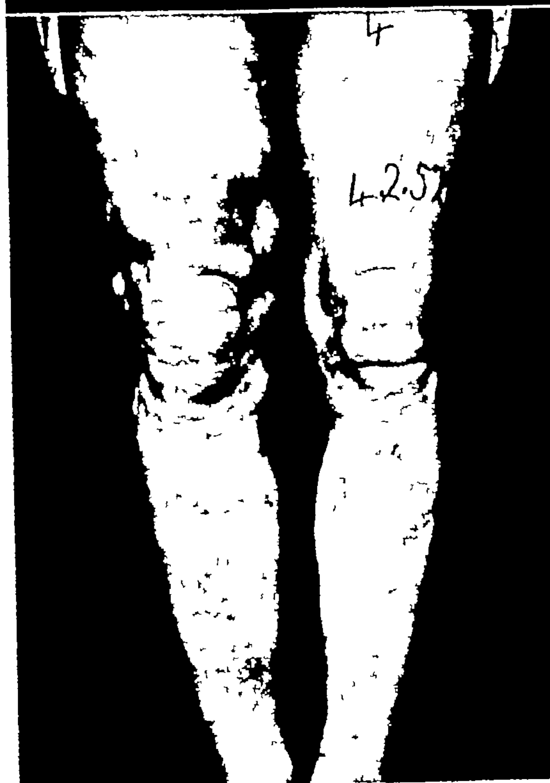




FIG 138

FIGS 135, 136, 137 and 138

A case of triple incompetence, i.e. varicosity of the internal and external saphenous veins and of a communicating vein in Hunter's canal

FIG 136 shows the veins at the front controlled by two thigh bands which occluded the internal saphenous vein and the perforating vein of Hunter's canal

FIG 137 shows the result after ligation of these two veins and stripping of the long saphenous trunk

FIG 138 shows that the varicose short saphenous veins had been overlooked

back of the thigh and calf, overlying clusters of varices a presentation which is seldom seen with the saphenous varicosities.

The internal iliac vein and its tributaries may be the only source of venous incompetence, *i.e* the internal and external saphenous veins and communicating veins of the thigh and leg are sound



FIG. 139

Internal Iliac Incompetence.
Varicose veins due to incompetence of a peripheral tributary of the internal iliac vein.

Ordinarily these varices are not unduly prominent although Martorell (1951) says that they comprise a very important percentage of the cases of varicosis that he sees. He further remarks that " generally clinical localisation of the communicating vessel is difficult and phlebography reveals the existence of multiple inefficient communications whose ligation is practically impossible or at least not to be recommended."

Test for Internal iliac vein incompetence—The distribution of these varices raises the possibility in the clinician's mind, because it is not typical of those from an incompetent internal or external saphenous and communicating veins (Fig. 139)

FIG 135





FIG 137





FIGS 135, 136 137 and 138

A case of triple incompetence i.e. varicosity of the internal and external saphenous veins and of a communicating vein in Hunter's canal

FIG 136 shows the veins at the front controlled by two thigh bands which occluded the internal saphenous vein and the perforating vein of Hunter's canal

FIG 137 shows the result after ligation of these two veins and stripping of the long saphenous trunk

FIG 138 shows that the varicose short saphenous veins had been overlooked

thirty two were on the right and one on the left. The vessels in each were gross causing repulsive disfigurements. They appeared first on the vulva the affected side was more distorted, but the mons labia majora and introitus were greatly enlarged bilaterally (Fig. 140) The veins of the perineum inner and upper thigh merged and were much enlarged Large cuticular and subcuticular varices disfigured the back of the thigh popliteal space and calf irregularly In all the internal and external saphenous veins were efficient to the tourniquet tests, one being confirmed by operation After emptying while the sapheno-femoral junction was occluded the varices filled promptly



FIG. 142

After old deep thrombo-phlebitis, varicosity of the internal saphenous vein, especially of the superficial external pudic vein and its tributaries and antero-external vein of the thigh. Note the slight swelling of the affected limb

The filling vessels appeared to emerge from the deep fascia at the inner fold of gluteus maximus a larger one appeared one inch below this groove on the postero-internal aspect of the thigh. *In two patients the veins were* kept collapsed after emptying by pressing the curve between the fully abducted thumb and index finger on the inner fold of the buttock, indicating that filling was from an incompetent peripheral tributary of the internal iliac vein One patient was relieved by ligation of these veins in the gluteal fold (Figs. 140 and 141) The vulval veins were injected and thrombosed to reduce the risk of haemorrhage during delivery which was normal The other two women stayed in bed for the last two months of their pregnancy One delivery was uneventful and the varices subsided. The third had a severe *haemorrhage* during the second stage of her labour but it stopped with the completion of parturition and her varices had disappeared two months afterwards

In these rare presentations, the cause of the varices was the pregnancy and the mechanical pressure on the internal iliac vein by the advanced gravid uterus.

The cough impulse and percussion tests for the internal saphenous vein are negative.

Three tourniquets are applied, round the knee, lower thigh and groin. These are released in turn and will probably show the external saphenous and communicating veins to be sound. The internal iliac varices and the internal

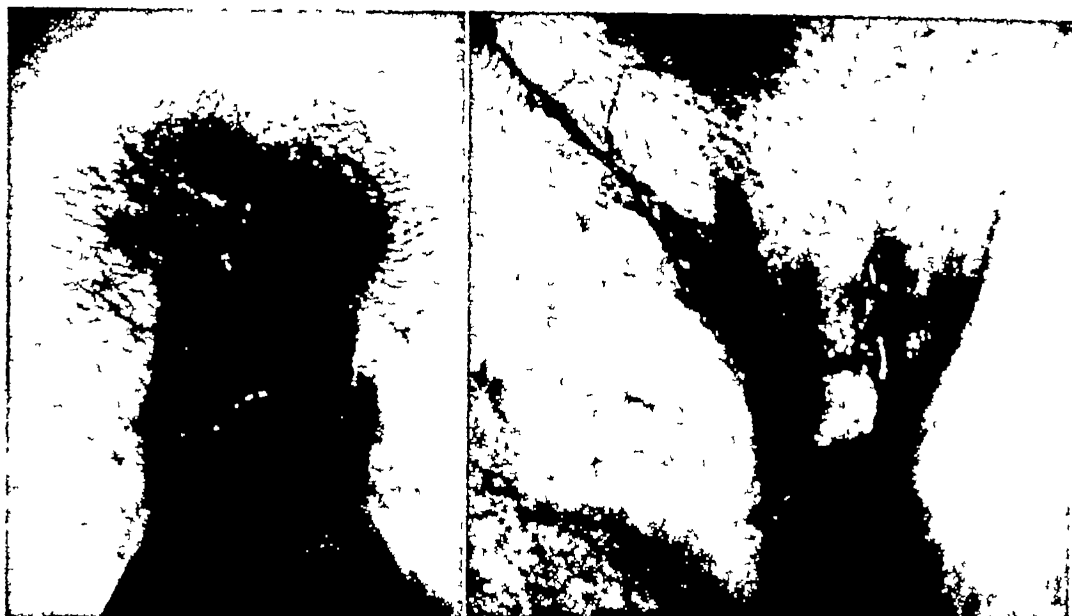


FIG 140 FIG 141

FIGS 140 and 141

Varicosities of peripheral tributaries of the internal iliac vein during pregnancy
FIG 140 Before operation FIG 141 After operation in the gluteal fold and exploration of internal saphenous vein (negative)

saphenous varices will fill when the upper one is removed. If filling of the internal saphenous vein is excluded by digital pressure and the test repeated it will be possible to see any retrograde distension of the internal iliac tributaries. Backflow from the internal saphenous vein is prevented as follows —

The upper tourniquet is applied and the patient stands. Pressure with the thumb is applied to the sapheno-femoral junction 1¼ inches external to and below the pubic spine. The tourniquet is released. Any varices due to internal iliac insufficiency steadily distend.

On palpating the varices, one or two may be found larger and more tense than the rest, this would suggest seeking nearby for the site of their penetration of the deep fascia. If direct pressure over such a point controlled the filling of some or all of the varices, this would indicate exploration of the area for an incompetent perforating vein and its ligation. Such points have been found on the postero- internal aspect of the upper part of the hamstring muscles.

Three striking cases of unilateral varicosity of the peripheral tributaries of the internal iliac veins during pregnancy have been seen in women under

thirty two were on the right and one on the left The vessels in each were gross causing repulsive disfigurements They appeared first on the vulva the affected side was more distorted but the mons labia majora and introitus were greatly enlarged bilaterally (Fig 140) The veins of the perineum inner and upper thigh merged and were much enlarged Large cuticular and subcuticular varices disfigured the back of the thigh popliteal space and calf irregularly In all the internal and external saphenous veins were efficient to the tourniquet tests, one being confirmed by operation After emptying while the sapheno-femoral junction was occluded the varices filled promptly



FIG. 142

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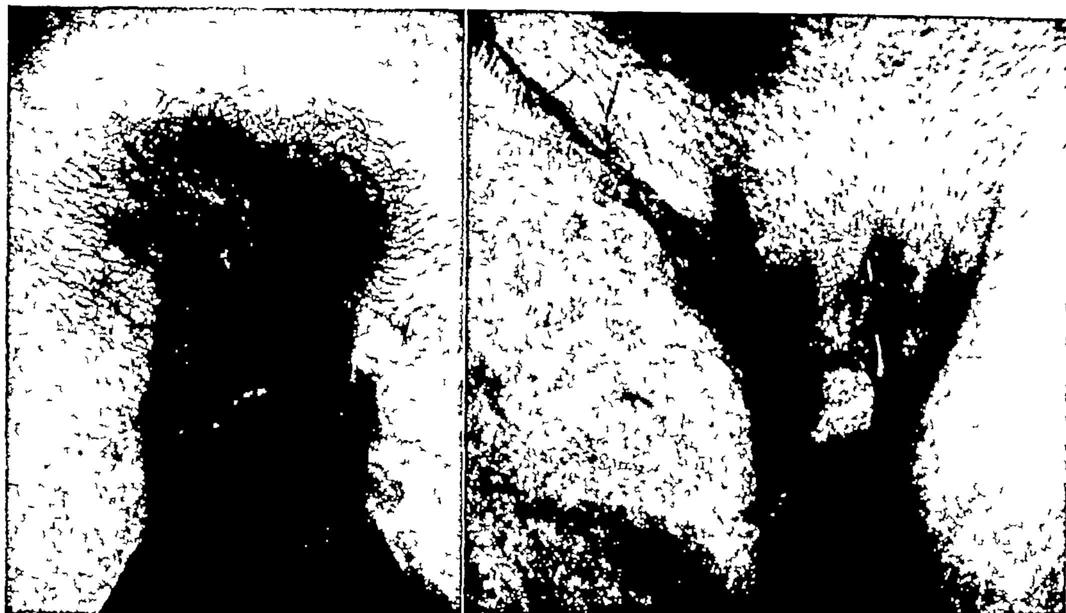


FIG 140 FIG 141

FIGS 140 and 141

Varicosities of peripheral tributaries of the internal iliac vein during pregnancy FIG 140 Before operation FIG 141 After operation in the gluteal fold and exploration of internal saphenous vein (negative)

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Three striking cases of unilateral varicosity of the peripheral tributaries of the internal iliac veins during pregnancy have been seen in women under

The diagnosis follows the lines already detailed by the cough impulse percussion test seeking for the filling source by emptying the veins and maintaining pressure (with the tourniquet or thumb) at first one and then the other sapheno-femoral junctions by pressure (Fig. 145)



FIG 145
Varicosity of the superficial epigastric veins following acute perforated appendicitis and left deep thrombo-phlebitis. Pressure on the sapheno-femoral junction indicates the direction of flow

11 Cuticular naevi

"Showers" of fine cuticular varicules, spider or naevoid in form present in the buttocks thigh and upper leg, especially in women. Although disfiguring they are of little account clinically They may be associated with faulty small perforating veins beneath them They appear with pregnancy and often disappear after it. They may become permanent especially in middle-aged obese women, perhaps associated with varicosity of the saphenous systems They are eyesores to patients but seldom call for direct treatment.

12. Varicose veins and arterio-venous fistulae

This condition is becoming more frequently recognised now that the possibility is realised It may be congenital or acquired it is not proposed to

10. Varices of the lower abdominal wall

A few patients are seen with varices of the lower abdominal wall especially affecting the veins of the pubis (Fig 142) or the superficial epigastric veins (Figs 143 and 144) Occasionally the pubic dilations are considered to





FIG 143 FIG 144

FIG 143—Abdominal varices mainly of the superficial epigastric veins and bilateral varicose internal saphenous veins following acute appendicitis with general peritonitis and deep thrombophlebitis

FIG 144—After bilateral sapheno-femoral ligation, internal abrasion and sclerosing injection of the long saphenous trunks Note the incisions

be a hernial protrusion especially in the female In some instances these varices are solitary, in others they are associated with varicose internal saphenous veins, either uni- or bi-lateral (Fig 143)

In both groups there has usually been a previous deep thrombosis The solitary vessels probably follow a segmental thrombosis of the femoral and external iliac veins, but where the varicosity is more widespread then the deep venous involvement has been greater

tion An arterio-venous aneurysm was present in the tibia He remarks "the difficulties in treating arterio-venous fistulae in the extremities are due either to the multiplicity of the fistulae in the soft tissue or to an arterio-venous fistula in bone, or to a combination of both." He concludes that congenital arterio-venous fistulae in the extremities are an intractable disease

A further case is described by Braithwaite and Tibbs (1955) of varicose veins of the buttock and posterior thigh being caused by a double arterio-venous fistula between the internal pudendal vein and artery Division of these cleared the veins

We have treated a boy aged twelve whose arterio-venous fistula caused (1) gross overgrowth of the tibia and fibula ($4\frac{1}{2}$ inches) and foot, (2) gross atypical varicose veins mainly in the internal saphenous area (3) gross oedema of the foot and lower half of the leg, (4) scaliness about the malleoli and ulceration with secondary haemorrhages

An attempt to clear the varicose veins failed others appeared The ulceration persisted and bled. His general health was impaired. An attempt to locate the fistula above and below the knee failed The leg was amputated below the tibial tubercle and a remarkable improvement in his mental and physical health followed quickly

13 Indefinite findings and the variability of veins

INDEFINITE FINDINGS —Perhaps no clear diagnosis is forthcoming when the tests have been performed carefully The possibility of defective smaller communicating veins should be considered. Occasionally when the constrictions are in place and the person is standing the veins appear to be full but palpation reveals that there is no pressure in them or they are but slightly distended, possibly due to thickened veins, incomplete emptying or to too tight or too slack a constriction band Repetition of the tests three or four times may be necessary to make a diagnosis Assistance may be gained by the patient standing with the bands on and watching what happens when a vigorous cough is made and also when the patient stands on his toes once or twice The lower veins may fill which would suggest incompetent deep and communicating veins. The obscure diagnoses are the exception rather than the rule. A partial diagnosis is not difficult but a complete explanation of the varices is sometimes baffling.

Many patients will be examined before clear-cut examples of each diagnosis are found A previous history of a persistently swollen foot and leg after an accident, *e g* a broken leg, operation pregnancy or illness is suggestive of an attack of deep thrombo-phlebitis (which may be bilateral too) recanalisation of which will be followed by defective deep and perforating veins

A feature which will modify the findings and perhaps confuse the diagnosis is that shown by both Warwick and Dow They demonstrated

deal with the latter because the history of injury to the limb will usually lead to the diagnosis and point the way to treatment



FIG 146
Inconspicuous varicose veins due to a large arterio-venous fistula in the popliteal space, they pulsated slightly

Congenital arterio-venous fistula causing varicose veins was hinted at by King (1950), whilst Piulachs and Vidal-Barraquer (1953) consider that all varicose veins have this basic aetiology We have read this detailed work and cannot accept it

Nevertheless there are arterio-venous fistulae associated with varicose veins Their presentation varies with the size of the fistulae When large the varicosities present in boyhood and are associated with an increase in size and growth of the leg and foot, usually unilateral

The veins are gross and atypical They often pulsate, there may be a murmur audible in them The skin has various naevoid staining and this may be the factor which causes the patient to seek treatment In the vicinity of the fistula, the skin is markedly warm The lower leg, ankle and foot often become the seat of swelling eczema and ulceration The skin is colder beyond the fistula In the established case, the oscillometric reading is increased above the fistula and reduced below it

When the fistula is small, then the veins appear later in life and the diagnosis is based on the warm skin atypically distributed veins which pulsate and give the responses which are characteristic of communicating veins Figure 146 illustrates innocuous varicose veins at the knee which pulsated, and were associated with warm overlying skin and an ulcer at the external malleolus Exploration of them revealed an enormous pulsating plexiform intramuscular aneurysm, which surrounded the condyles of the femur The operation was not continued into the popliteal space, where it was considered the fistula probably lay

An illuminating case was reported by Nisbet (1954), where a large aberrant artery was found passing into the tibia, having caused it to overgrow Ligation relieved the woman of ulceration of the ankle and foot with enlarged veins for several years, but ultimately the condition recurred and amputation was necessary to give relief from pain, haemorrhage and ulcera-

14 Compensatory veins to thrombosed deep veins

Before the treatment of varicose superficial veins of the lower limbs is ıdered thought ıs given to the question whether they are primary or ıpensatory to past or present thrombosis or obstruction of the posterior ıl popliteal femoral or iliac veins

Following deep thrombophlebitis until the deep veins recanalise the rn circulation may be in part transferred to the superficial veins These enlarge and possibly become varicose in appearance, although not ssarily varicose in fact. The tests will indicate their true state. To terate distended subcutaneous compensatory vessels as if they were vari ties would be a disservice to the sufferer The history and examination, ıld suggest the deep thrombosis while the limb swollen in part would cate a deeper lesion and contra-indicate any procedure on the legs at any : for the time being (*see* Chap XII)

Degrees of varicosity

Of recent years for clinical purposes it has been found useful to put ıcose veins of the internal saphenous vein into three classes

Class 1 —This includes those veins which give *no* definite response to tourniquet and cough impulse" tests. It includes varices that are erally referred to as the "trivial" "vanity" or nylon" veins *i e* the ıle prominent vein or isolated cluster

Class 2 —This comprises those varicose veins which give a positive result he tourniquet test, but a negative response to the cough impulse test. ıghtly varices and aching leg are the complaints with these they seldom se swelling skin changes eczema or ulceration

Class 3 —This contains the gross presentations of varicose veins where *results of the* "cough impulse and tourniquet tests are indubitably and matically positive Varicose veins complicated by swelling, ulceration or ema are almost invariably of this class Readers will recall that a positive ough impulse" test indicates that there is a column of blood uninterrupted valves from the leg and thigh through the sapheno-femoral junction to heart and therefore the pressure in such varicosities during coughing and ıning may reach 200 mm of mercury (Warwick, 1931)

Test for the efficiency of a vein at operation

Occasionally at operation for varicose veins it is necessary to determine efficiency or otherwise of a saphenous trunk. Examples are —

1 An operation for varices in the perineum genitalia or upper thigh ıng from inefficiency of the superficial external pudic vein a tributary of internal saphenous vein or from a defective peripheral vein of the internal

iliac vein The efficiency of the internal saphenous vein must be tested, if it is faulty a sapheno-femoral tie will be needed

2 A varicose vein was found to enter the popliteal space and to join the popliteal vein The external saphenous was somewhat large but had been inconspicuous at the clinical examination, and the question of its efficiency and the necessity of doing a sapheno-popliteal ligation and external saphenous stripping arose

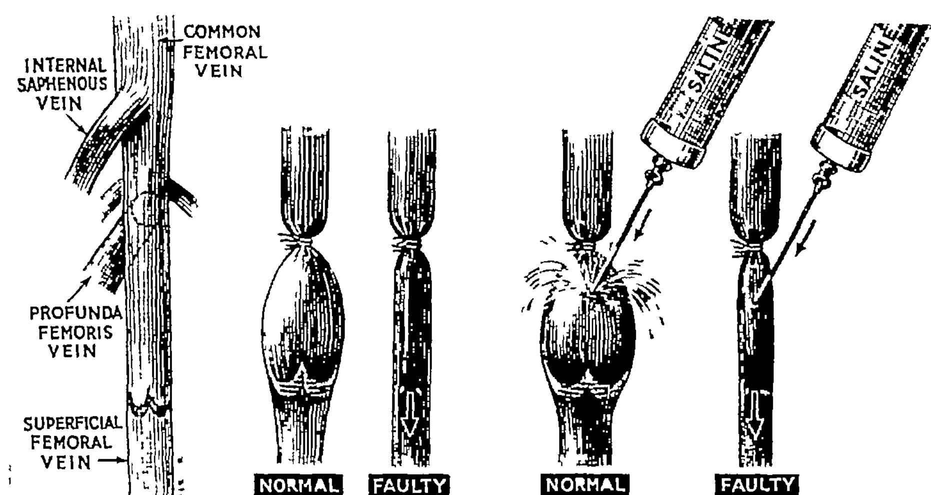


FIG 147
Testing a vein at operation for the competence of its valves by a rapid retrograde injection of 20 ml of saline

3 In a few instances (*see* Chaps XIV and XVII) a patient may benefit from ligation of the popliteal or femoral vein Direct evidence of their defective valvular state before proceeding with such a ligation is needed

The test is carried out as follows (Fig 147) The vein in question is defined for 1½ inches A strand of thick catgut or tape is passed round its proximal part twice and held with a heavy haemostat, its weight will hold the ligature tight enough to occlude the vessel and yet not to damage it

A syringe with a medium-sized needle is filled with 20 ml normal saline which is injected rapidly into the vein in a retrograde direction Two results are possible —

1 The vein distends immediately and the saline squirts out, alongside of the needle This vein is efficient, for its valves are preventing a retrograde flow

2 The syringe can be discharged repeatedly as quickly as it is possible and the vein is unaffected in size This vessel has inefficient valves and can be dealt with, as such a defect seems to require

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CHAPTER VII

THE TREATMENT OF VARICOSE VEINS BY INJECTIONS

SCLEROSANT fluids and their action.—The purpose of an injection of a sclerosing agent into a varicose vein is to destroy its endothelium, as a result an aseptic chemical phlebitis follows and the blood clots in the affected section Granulation tissue from the subendothelial coat grows into the thrombus formed, and in suitable circumstances it is converted into fibrous tissue, the vein becomes a solid fibrous cord which is sometimes palpable as a fine string in a thin limb This is the ideal and in suitably selected and correctly treated vessels it does occur, as instanced by numerous limbs so treated and inspected for years afterwards without a return of the varicosities

It is not achieved when the varicose vessel is in direct connection with blood circulating under high pressure, as for instance from an incompetent internal or external saphenous or a faulty communicating vein When these are inefficient, the circulation both in pressure and volume is so great during activity that even if thrombosis is induced in an injected varicose vein re-canalisation almost always takes place A potent agent at work about the clot, is that of cellular activity arising from the intima and from the cells in the blood These remove the thrombus by their digestive power, so that the vein recanalises in three to twelve months, its wall remaining merely thickened by an increase in fibrous tissue and its lumen honeycombed by criss-cross residual fibrous strands, especially at the valves It is emphasised that thrombosis in varices is a result of the sclerosant's action on the venous intima (possibly due to intimal dehydration), and in some cases on the media, and *not* to its effect on the blood in the vein The older technique of injecting a caustic fluid that also produced clotting, such as that of pure carbolic acid, has been abandoned because of its tendency to produce bulky painful clots in the superficial, perforating and perhaps the deep veins with occasional embolism The fundamental effect of a good sclerosant is destruction of the venous intima and possibly of the media, localised to the varicose veins injected

OTHER EFFECTS OF A SCLEROSANT —In addition to the effects on the vein wall in the vicinity of injection, the sclerosing medium may exert its irritating action on —

(*a*) The endothelium of a varicose portion of the same superficial system, remote from the injection which may also become thrombosed

(*b*) The perivenous tissues of the injected vein, either because of faulty technique (*i e* a perivenous injection), or because the solution has permeated

the vessel wall, or leaked through the needle puncture varying degrees of periphlebitis follow

(c) The communicating veins between the superficial and deep veins in the area which are possibly sclerosed and thrombosed

(d) The adjacent deep veins and their valves which may be similarly affected and thrombosed and permanently damaged, if the sclerosant is sufficient in amount and concentration

(e) *The person as a whole* The sclerosant by mingling with the circulating blood produces a general effect to an extent depending on its composition the amount and speed of its introduction and on the susceptibility of the patient to it, *e g* cinchonism after an injection of quinine and urethane, an allergic collapse after sodium morrhuate or ethanolamine (ethamolin)

The history, progress and safety of sclerosant therapy

THE HISTORY OF SCLEROSING INJECTIONS —The injection of varicose veins developed shortly after the introduction of the hypodermic syringe It arose out of the clinical observation that an attack of spontaneous thrombophlebitis in varicose veins was occasionally followed by their cure. Pravaz (1857) used sclerosant therapy in 1851 when he injected a solution of ferric chloride into an aneurysm in the hope of causing permanent thrombosis in it. This was used by Chassaignac (1855) in 1853 for injection treatment of varicose veins since when many substances have been tried.

In 1904 Tavel of Berne combined the operation of ligation with the injection of carbolic acid 5 per cent. and made a convincing case for his method. Schiassi (1908) injected 1 per cent. iodine in 1 per cent. aqueous potassium iodide From 1912 onwards mercuric chloride was tried for this purpose by Linser (1916 and 1921) but the general toxicity of this drug as shown by transient albuminuria and the gross damage that resulted from leakage into the perivenous tissues prevented this from making a general appeal Sicard (1922) introduced sodium salicylate injections giving 2 ml of a 20 per cent. solution as the first dose and 2 3 ml of a 30 40 per cent solution after two to three days. Sicard stated that it was effective, harmless and painless He had tried salvarsan and sodium carbonate but had found them too caustic K Linser (1925) used a 15 20 per cent. solution of sodium chloride sugar in various forms was also tried (Kausch 1917 Nobl 1926) Quinine as a varicose vein sclerosant was first used in 1913 (Hanschell 1928) and later urethane was added as a local anaesthetic (Génévrier 1922) Subsequently it was used synchronously with lithocaine (lithium salicylate 30 per cent. tutocaine 1 per cent.) as the " twin " injection (Maingot and Carlton 1928 Harvey in 1936) Other remedies have been tried since

PROGRESS OF INJECTION THERAPY — The fear of fatal embolism is so ingrained in anyone who has observed the tragedy of its occurrence in a patient

who has reached the pleasant state of convalescence after a major but successful operation, that the almost universal and unquestioning belief in the danger of a deliberately induced thrombosis generally deterred the medical profession as a whole from attempting to cure varicose veins by injection in the period *1880-1920* " (Warwick, *1931*)

In spite of this fear, however, individual efforts continued to be made to develop the method into a safe yet sound remedy Gradually its effectiveness was established and confidence in the method was won, until in the period 1920-35 the injection of varicose veins was the method of choice for their treatment

Since 1935, its scope has narrowed from its erstwhile use for every case of varicose veins, because a high percentage of recurrences followed (Howard *et al*, *1931* , *Faxon, 1933*)

It is still a useful remedy with the correct selection of the varicosity, material and technique, although its use has greatly contracted In expressing this opinion, however, the disapproval of sclerosing injections by other workers must be stated in order that readers may be assisted to a fair evaluation (Fratkin, 1951)

EMBOLISM AND THE SAFETY OF INJECTION TREATMENT —" The question of the theoretical danger of embolism as a complication of the injection treatment must be considered The practical answer to the question lies in the immense number of cases that have been treated and the few fatal cases found in the literature "

" If the absence of records of death be regarded as somewhat negative evidence, the fact that very large series of cases have been recorded with no death shows that the risk of embolism is negligible Thus, Payne quotes Linser's records of 6,000 *cases and Nobl's 2,950 cases without a death* "

" Forestier (1928) in a discussion on varicose ulcers, reported that Sicard and his co-workers had made over 300,000 injections of sodium salicylate, and nearly 25,000 injections of quinine, and they had not one case of pulmonary embolism to report " (Warwick, 1931)

A personal series on our records is of about 30,000 injections given since 1940, without known embolism or fatality

The injection treatment of varicose veins in careful hands may therefore be regarded as free from danger

The explanation advanced for this freedom from embolism after injection treatment is that the thrombi that form are closely adherent to the vessel wall by the associated phlebitis They are never soft and loosely attached, as are the much-feared ones of phlebothrombosis that result in a post-operative embolus

We have never seen embolism after the injection of a varicose vein Embolism could arise from the thrombus in the superficial veins becoming detached, or from it propagating via a perforating to the deep veins and breaking off into the main venous stream This is possible when a person who is immobilised for a considerable period after injection starts to move

her an incumbrance When the incompetent communicating veins have divided injections may be carried out cautiously if the varices require it.

Aged and debilitated persons—Elderly persons and unstabilised diabetic its are examples of those in whom caution and preliminary treatment is ed for before a course of sclerosing injections *No person who is unwell inactive should be injected as movement is the protection against a deep read of thrombosis*

Fibrosed varicose veins—Fibrosed varicose veins are like india rubber ubing, their rigid walls tend to keep patent, they are unlikely to close permanently Because of this these vessels are better excised, as by stripping, or failing this *sustained* pressure for a month must be made on them by a pad and compression bandage for the purpose of keeping them collapsed and inducing their walls to adhere permanently after the sclerosant has scarified their endothelium An encircling band of emplastrum-saponis (Diachylon strapping) is easily tolerated for three months by most people

Varices in scar tissue above the ankle—These are better not injected for three reasons. First, there is often an incompetent ankle perforating vein beneath them which transmits high intravenous pressure through them so a sclerosant injection is unlikely to cause an obliterative thrombosis in these vessels or if it does it will be rapidly recanalised.

Second tissue where ulceration is or has been is impoverished and the reaction following an injection might precipitate tissue necrosis for an appreciable area causing a slowly healing ulcer

Third, a thrombus here can quickly extend to the posterior tibial venae comites because the communicating veins here are short and direct.

Proved sclerosants.—The sclerosants detailed here have been used by many operators for years with safety and effect, and we can vouch for their usefulness under the conditions mentioned

THE STERILITY OF THE SCLEROSANT—Most of the sclerosing solutions used are strong antiseptics and are self-sterilising but they should be chemically stable and sterilisable by autoclaving. No dependence should be placed upon a solution s self-sterilising powers and throughout its preparation and use it should be handled with aseptic technique The salicylate and the phenol glycerine solutions are self-sterilising. The sclerosant should be drawn from ampoules rather than from rubber-capped bottles although such a container is permissible in a clinic where several are used during the course of a few hours and the partially empty ones are discarded afterwards

The components of the sclerosing solution must be pure chemically and ...ically The water must be triple distilled and pyrogen free or rigors follow

pregnancy, the menopause or advancing age These may be classed as recurrences, but in our experience this is not entirely so, many are fresh varices, being developments of the above incidents In any case, the gospel that effective treatment for varicose veins is available is spread

(c) When operation is undesirable for reasons of concomitant systemic disease or old age Some patients are unable for social reasons to give the time required for an operation In such circumstances, injections performed by a surgeon experienced in this therapy, combined with efficient elastic stockings, pressure bandaging, etc, assist these persons, although as a rule only for a matter of months, recanalisation is almost invariable

(d) Spontaneous superficial thrombophlebitis and injections In a patient suffering from spontaneous superficial thrombophlebitis of gross varicose veins, we perform sapheno-femoral or sapheno-popliteal ligation as soon as possible, followed by sclerosing injections

If the veins are not such as to require the strategic ligation, then provided the patient is *steadily ambulant,* we give sclerosing injections into the adjacent patent varices The objective is to provoke such a destructive reaction in the varices that they will fibrose and permanently obliterate instead of the usual recanalisation in the following three to six months We have practised it since 1940 without mishap or regret A firm pressure bandage or elastic stocking is maintained over the thrombosed vessels by day and night for at least four to six weeks to keep the veins flat and ribbon-like during organisation and fibrosis (Chapter XV)

CONTRAINDICATIONS TO INJECTIONS —Sclerosing injections are inadvisable in the presence of the following conditions —

Cardiac disease—Where there is uncompensated heart disease the injection should not be given If the disease is compensated and the patient is capable of some positive activity and the veins are painful, or eczema and ulceration are threatening, the treatment may be attempted

Peripheral arterial disease—The presence of an inadequate peripheral arterial circulation means that caution must be exercised with these limbs as the tissues are able to withstand only a slight reaction before necrosis is precipitated

Asthma—Lutton and Grant (1953) suggest that asthmatic patients should be injected with care

Old phlebitis of deep veins was formerly held to be a contraindication to the injection of superficial varices This cannot now be accepted While superficial veins may occasionally be compensatory, the usual state of affairs is that the venous circulation is hampered by the superficial varicosities which are comparable to the varicose veins of the primary type The superficial dilatation, therefore, is usually of no value to a hard-pressed deep circulation,

but rather an incumbrance When the incompetent communicating veins have been divided, injections may be carried out cautiously if the varices require it.

Aged and debilitated persons—Elderly persons and unstabilised diabetic subjects are examples of those in whom caution and preliminary treatment is called for before a course of sclerosing injections *No person who is unwell and inactive should be injected as movement is the protection against a deep spread of thrombosis*

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The components of the sclerosing solution must be pure chemically and bacteriologically The water must be triple distilled and pyrogen free or rigors and pyrexia may follow

PHENOL-GLYCERINE —Of the solutions to be mentioned the phenol-glycerine fluid has been found the most satisfactory It is based on Riddoch's (1946) solution of phenol 2 per cent, glycerine 30 per cent One of us began to use it in October, 1946, and has continued to do so since In the period October, 1946 - December, 1952, in the consulting room at least 2,000 - 3,000 patients were injected annually personally, one to four injections per session being given to each No immediate or late local ill-effects have been observed Very rarely a patient has felt faint and needed a glass of water. An injection ulcer has occurred in only four persons in seven years

By a process of trial and error, a fluid of the following composition has been found to be effective and safe, viz, phenol crystals 2½ - 3 per cent, glycerine 25 - 30 per cent It is tinted with a trace of methylene blue to distinguish it from saline, methylated spirits, water, adrenaline and other colourless solutions, such errors have been made and have attracted publicity at the inquests which have followed the mistaken injection of these solutions, not to mention claims in the Courts for damages The weaker solution is used for cuticular varices and naevi, where the vitality of the tissues is suspect and in older persons

Phenol-glycerine is a fair sclerosant The resulting thrombosis is moderate and not bulky The ensuing tenderness lasts for one to seven days It seldom gives rise to pain, periphlebitis or extensive swelling, and it is exceptional for a patient to be incapacitated by it for even a short period, or for local necrosis to occur

Sterilisation —The phenol-glycerine solution, although a self-sterilising fluid, is prepared from the purest phenol crystals, glycerine and apyrogen water, and is autoclaved before use

Risk of thrombosed deep veins —Phenol-glycerine sclerosant does not tend to affect the deep veins, for no case of this has been seen since its use was begun in 1946 The solution fails to thrombose when it is diluted by a quarter of its volume, *i e* to less than 2 per cent phenol, which rapidly occurs in deep veins

Tissue necrosis —When phenol-glycerine is injected into the tissues, a swelling is immediately apparent and an instant sharp warning pain follows, causing involuntary movement and an audible inspiration The surgeon stops injecting promptly and checks that the needle point is in the vein, by exercising suction with the syringe plunger, before proceeding The pain passes off within a minute, due to the anaesthetising effect of the phenol When the fluid has been inserted paravenously, an injection ulcer rarely follows; four cases have been seen in over ten thousand patients to whom it has been given

Dosage —The volume of solution used is 1 - 2 ml and, if required, three to four such insertions may be given at a session The aim is to avoid causing the patient so much pain that he is unduly inconvenienced, incapaci-

tated or prevented from following his occupation because enforced rest is conducive to the spread of the thrombi deeply

The constitutional effects of phenol glycerine solution —In a few patients temporary giddiness has followed an injection but no patient has fainted or collapsed a few have needed a sniff of smelling salts or a drink of water Some intelligent persons have stated that they could taste the carbolic acid shortly after the injection had been given to them

Bleeding after injection —The only slight disadvantage of the injection of the phenol-glycerine fluid is one that is common to all sclerosants that of bleeding from the puncture for a minute or so It is easily overcome by the light pressure of the patient s finger on a swab for two minutes as he sits or reclines on the couch this pause is in any case essential in order to give the sclerosant time to act on the endothelium before it is swept away by the circulation which restarts the moment movement begins (Fig. 152B)

QUININE AND URETHANE.—In 1921 Génévrier introduced the injection of quinine hydrochloride 13 3 per cent (4 grammes) and urethane 6·6 per cent (2 grammes) in distilled water as a sclerosant This combination is still in use though quinine hydrochloride 11 5 12 5 per cent w/v and urethane 5 5 6 5 per cent. w/v are the usual strengths It is an analgesic solution The urethane exerts an anaesthetic action and also raises the solubility of the quinine salt in water The solution is stable is strongly antiseptic and can be boiled or autoclaved When it is cold it deposits crystals and, therefore it requires inspection and perhaps warming before injection, otherwise the crystals jam the syringe and block the needle as well as the solution being dilute

Dose —After an initial dose of $\frac{1}{2}$ ml to test the patient s sensitivity to quinine it is injected subsequently in amounts of $\frac{1}{2}$ 2 ml using a maximum of 6 ml. per session

Effect —It does not cause immediate discomfort. A slight burning pain may be felt spreading along the vein injected The patient may have a bitter taste in the mouth shortly afterwards The quinine acts on the endothelium and subendothelial tissues A hard painful thrombosis follows sometimes associated with local swelling. When it is injected paravenously instant pain occurs and a necrotic ulcer develops if it is continued. When it is given during pregnancy the quinine may induce abortion or induce labour or if the patient is menstruating it may stimulate a colicky uterine hypogastric pain or restart a recent period On the whole it is a dependable and safe sclerosant, although immediate faint symptoms of cinchonism may follow in sensitive persons It is a useful alternative to the phenol-glycerine solution when this is not available or ineffective in the varices under consideration.

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Tissue necrosis —When phenol-glycerine is injected into the tissues, a swelling is immediately apparent and an instant sharp warning pain follows, causing involuntary movement and an audible inspiration The surgeon stops injecting promptly and checks that the needle point is in the vein, by exercising suction with the syringe plunger, before proceeding The pain passes off within a minute, due to the anaesthetising effect of the phenol When the fluid has been inserted paravenously, an injection ulcer rarely follows; four cases have been seen in over ten thousand patients to whom it has been given

Dosage —The volume of solution used is 1 - 2 ml and, if required, three to four such insertions may be given at a session The aim is to avoid causing the patient so much pain that he is unduly inconvenienced, incapaci-

urethane is necessary to precipitate fully the lithium solution but excellent results follow their use in equal doses

Effect.—An extensive painful thrombosis with considerable periphlebitis results When the varicose internal saphenous vein is injected the entire trunk may thrombose from the ankle to the saphenous opening although this is not an objective Occasionally after the procedure of sapheno-femoral ligation internal abrasion and injection of the internal saphenous vein at the groin and ankle a section of the main vein remains patent at the knee In a few instances injections of phenol-glycerine solution have failed to close it but the "twin" injection, with a pressure bandage afterwards, has always occluded it.

Administration.—The administration of the "twin" injection is by one or two techniques, both designed to keep the fluids apart until they are in the vein. Should they make contact in the syringe the tacky precipitate will make the piston stick and block the needle

(*a*) *The single puncture method*.—One syringe is charged with 1 2 ml of quinine-urethane another with lithocaine 1 2 ml and a third with 0 5 ml of sterile distilled apyrogen water (ordinary boiled water is unsuitable because it contains pyrogens) Only one needle is required The first injection of quinine is given slowly into the centre of the varix it is wished to sclerose Before the syringe is gently detached from the needle, suction is applied to check that the needle is clearly in the vein The second syringe containing 1 ml. of sterile water is connected and emptied into the vein this clears the needle of quinine Again aspiration is made to confirm that the point is still in the lumen The third syringe containing lithocaine is applied to the needle and slowly discharged into the vein after once more withdrawing blood to check that the needle point is in the vein The weakness of this method is that the change of syringe may move the needle out of the vessel and a paravenous injection of lithocaine made which causes necrosis With practice however the method is satisfactory because it is usually reserved for the larger varices and there is little difficulty in maintaining the needle in place The administration is made slowly so that there is time for the sclerosant to spread superficially without creating eddies and not to pass deeply

(*b*) *The two-puncture method* (Fig. 149).—The second technique requires two syringes and the instillations are given through separate punctures The patient sits or lies with the leg slightly dependant or horizontal The lithocaine is injected at the upper end of the length of vein it is wished to sclerose and the quinine at the lower conveniently prominent vessels are chosen The fluids slowly intermingle and an effective thrombophlebitis results in the section of the vein between and around the punctures It may spread considerably up and down and cause an acute chemical periphlebitis which includes the overlying skin Ideally two operators are required for this tech

nique, the injections being made synchronously, although they are always successful if the syringes are filled ready and discharged one after the other, especially with the legs in the horizontal or slightly dependant position, in which circumstances the circulation is minimal Patients sit or lie with the legs on the couch for at least five minutes afterwards

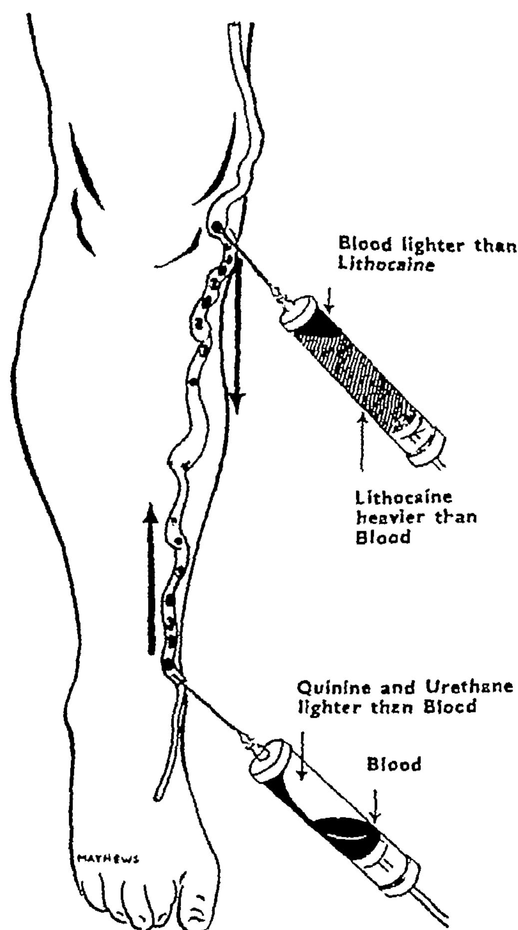


FIG 149
The principle which underlies the "twin" injection Sclerosing fluids like lithocaine which are heavier than blood are injected at the upper end of the vein to be sclerosed and the lighter agents such as quinine and urethane at the lower end

In this way it is possible to block temporarily an unligated faulty internal saphenous vein and to accelerate healing of an ulcer so that an earlier radical operation can be performed We have never seen thrombosis of the deep veins or an embolism follow one of these "twin" injections made in the consulting-room Superficial pain of some severity in the leg is usual for several days Patients are warned of this, aspirin and codeine are prescribed and they are instructed to take them as necessary in order to "carry on as usual" by day and to assist sleep at night

The two methods are used for different presentations of varicose veins the single puncture for a cluster and the double one for a length of varicose vessel, *e g* the posterior arch vein from the ankle to the knee

AETHANOLAMINE (Monoethanolamine 5 per cent with Benzyl Alcohol 2 per cent)—Various proprietary preparations are Ethamolin, Monethan, Neovaricane, etc.

Aethanolamine is sterilised by autoclaving

Dose.—It is given in 1 - 2 ml doses with a total of 6 ml per session

Effect—It is a good sclerosant of varicose veins, but causes a painful thrombosis We have not seen an injection ulcer follow its use

Toxic effects—Sensitivity reactions may occur One form is violent backache, pain in the neck and headache Occasionally collapse follows its injection, although 1 minim of adrenaline hydrochloride per 2 ml of Ethamolin prevents this—Kirkland (1947) Shelley (1939) reports a death after an injection of 4 ml of monoethanolamine oleate in a woman of fifty-

seven years of age. Foote (1944) reports a collapse with recovery in twenty four hours after an injection of 0·5 ml The authors have received personal reports of other collapses after injections of this substance but none of them were fatal

Death after an Injection of Ethamolin—An instructive fatal case was reported by Lutton and Grant (1953) A married woman aged forty three was given ethanolamine oleate 6 ml into her varices whilst standing this was her first injection She collapsed became unconscious and died. She was a chronic asthmatic patient and death was considered to be due to an allergic reaction to the injection The sclerosant was cultured and found to be sterile

We suggest that three errors of injection therapy occurred in this case first, the standing position (the patient should be sitting or lying) second, the excessive dose of agent (it should never be over 2 ml) and last, the omission to make a first trial dose of ½ ml for sensitivity purposes.

SODIUM MORRHUATE 5 10 PER CENT—This substance is still widely used in Britain and America since it was first published by Higgins and Kettel (1930) It is but a temporary sclerosant, *and it is mentioned here to condemn it strongly because syncope and death may follow its use* One of our patients died in 1930 almost immediately after an injection of 1 ml of 10 per cent in the standing position Other workers have reported anaphylactic reactions following its use (Zimmerman 1934 Lewis 1936 Dale, 1937) Praver and Becker (1935) reported 3 per cent. of unfavourable reactions with this substance It is of variable chemical composition and certain specimens contain toxic fractions (*e g* fish proteins) which cause these unpredictable morbid reactions Clay and Jackson reported a death in 1955 following an injection of it.

SOTREDECAL (sodium 2 tetradecyl sulphate) (Reiner 1946 Dingwall 1948)

This remedy is strongly recommended in the United States but it is not available in Britain It is a synthetic surface-active substance It is highly spoken of by Linton (personal communication) and Orbach (1950) whose technique is interesting He uses the empty vein technique, taking a small quantity of sodium tetradecyl sulphate 0·5 ml in a syringe and shaking it up to make it froth. He injects a bubble of air into the vein this clears the selected segment of blood and then the frothed sclerosant is inserted This is followed by a compression bandage (we agree that this is essential) He reports good results from this technique with small doses of sclerosant

CONCENTRATED SALINE SOLUTIONS (SODIUM CHLORIDE) 20 30 PER CENT—Strong solutions of sodium chloride are fair temporary sclerosants. They cause severe pain on injection but this can be neutralised by including procaine 1 2 per cent A large volume, 3 20 ml is required Paravenous injections are followed by extensive tissue and skin necrosis. Neither saline

nor concentrated fructose (50 per cent aqueous solution) have been permanently successful as venous obliterating agents with us Saline and glucose are safe constitutionally, being physiological constituents of the blood, but if injected rapidly their concentration may damage the deep vein endothelium Salt solutions are inadvisable because of the danger of skin necrosis; large volumes are needed and their sclerosing power is only moderate

EQUIPMENT FOR SCLEROSING INJECTIONS

A PNEUMATIC TOURNIQUET —A narrow band pneumatic tourniquet is comfortable and convenient Connected to a blood pressure manometer, accurate and steady pressures can be maintained The pressure in the cuff should be releasable without a jerk that could displace the needle point from the vein Alternatively, a piece of soft thin-walled rubber tubing, 1 cm in diameter, held by a large artery forceps, is efficient

NEEDLES AND SYRINGES —The needles are selected carefully and are of the finest quality They should be stainless, with a short bevel Record sizes Nos. 14, 15 or 16 are suitable, but they are chosen by the surgeon. Small needles make the least puncture in the vessel and are followed by a minimum of perivenous oozing, but they withdraw blood slowly, their lumen is quickly blocked and some operators find them difficult to use

Syringes of 2-5 ml capacity with an eccentric nozzle are convenient These, too, must be of the highest grade, as a leaking piston makes this dainty work tiresome, time-consuming and difficult, to inject a half-empty, soft-walled vein successfully is more difficult than injecting a tense, firm vein, as at the elbow

The sterilisation of needles and syringes —The needles and syringes are sterilised by boiling in distilled water or by autoclave, and laid out dry for use Immediately after an injection, the syringe is washed through several times with 1 in 20 carbolic acid and it is then dismantled Similarly, the needle is squirted through Prompt cleansing is essential to exclude the danger of transmitting infective hepatitis by means of a trace of blood remaining in the syringe or needle-cone The latter is regularly cleaned mechanically to remove small blood clots that are prone to lodge here If the used syringe and needle are not quickly squirted through, the blood in the needle-cone clots, which may block it in spite of a stilette, or act as a valve and prevent suction or discharge A stilette is threaded into the needle to ensure its patency and to protect the point

Syringe-transmitted hepatitis —"The virus of serum hepatitis has been shown to be destroyed by heating at 60°C for ten hours, and no virus is known to withstand boiling It is reasonable, therefore, to suppose that boiling for five minutes will render a syringe safe in this respect, though

absolute proof requires human volunteer experiments which have not yet been made. In any case the sterilisation of syringes by boiling represents the nearest practicable approach yet devised to a theoretically perfect technique If there is any risk that a properly boiled syringe can remain infected with hepatitis virus the risk is probably small enough to be ignored The use of the same syringe for more than one patient, without intervening sterilisation presents a much greater risk of transmitting hepatitis" (*Brit med J* 1951)

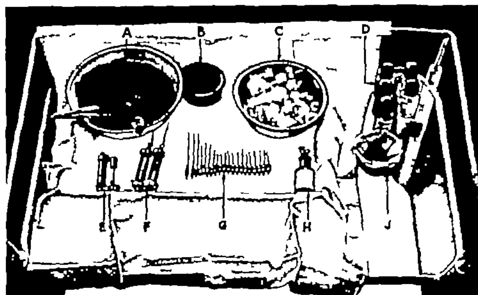


Fig 150

Instrument table laid out for the injection of varicose veins.

A. Bowl containing 1 in 20 carbolic acid.
B Gallipot containing weak iodine.
C. Sterile swabs. D Spare bottles of sclerosing solution.
E. Boiled syringe awaiting assembly prior to filling.
F Two syringes charged with sclerosant.
G Needles containing stilettes. They have been boiled and are laid out dry
H. Rubber-capped bottle of sclerosant, ready for charging syringes.
J Small pieces of plaster cut ready to cover the punctures.

We are unaware of this complication *i.e* serum hepatitis having occurred after a varicose vein injection but we think that with defective technique it is possible

Varicose vein injection clinic (Fig 150) —In a varicose vein clinic six syringes are prepared by boiling or autoclaving After their use, two techniques are available to resterilise them, preferably by boiling immediately or by chemical immersion the former is safer One of us used the chemical method from 1930 without traceable incident but since 1950 boiling after every injection has been practised

Boiling —The syringes and needles are used in rotation and after immediate cleansing they are dismantled and boiled for two or three minutes.

Chemical sterilisation—The chemical method of re-sterilisation is as follows.—

After flushing the syringe and needle with 1 in 20 aqueous carbolic acid, the syringe is filled with the carbolic lotion and completely immersed in a bowl of the same liquid, so that the inside and the outside are in contact with the antiseptic The syringes are used in turn, so about five minutes elapses between successive usage A freshly-boiled needle is taken for each person The phenol-glycerine used since October, 1946, is compatible with the 5 per cent carbolic acid technique for cleansing and sterilising The interior of the syringe is never bacteriologically infected, but it is admittedly contaminated with the blood which is sucked into it from the patient's vein Herein lies the faint danger of the transmission of the virus of infective hepatitis from the minute trace of blood lingering about the syringe, although it will have been in contact with the phenol for five to ten minutes If a sclerosant incompatible with carbolic acid is used, *e g* quinine, then chemical sterilisation is not used and the syringe is washed in water and boiled

TECHNIQUE OF INJECTION

The position of the patient

SITTING OR HORIZONTAL POSITION—The basis of this method is to take advantage of the static blood-stream which occurs in varicose veins in the supine and sitting position to avoid undue dilution of the caustic fluid by blood and to enable it to act directly for an adequate period on the venous endothelium and possibly to penetrate to the middle coat The effect of the sclerosant is thus localised superficially The possibility of its spread into the communicating veins and deeper systemic circulation with concurrent deep venous and constitutional effects is minimised The imperceptible dispersal of the sclerosant into the deep veins and general circulation protects the former from thrombosis and the patient from the toxic effects of the agent Kinmonth and Robertson in 1949 showed that an injection of radio-opaque sclerosant into the superficial veins of the leg, with the patient supine and immobile, stayed there for several minutes, but that any movement promptly swept the fluid into the deep vessels Dow (1951), injecting from the ankle, showed that it was difficult to make a radio-opaque fluid pass from superficial varicose veins to the posterior tibial veins of the leg when the person was supine, although it usually passed into the popliteal and femoral veins, he was, however, using volumes of 20 - 30 ml With doses of 2 ml. the tendency to invade the deep vessels is slight or negligible

The "empty" vein technique—Although the volume and movement of blood in the veins in the sitting or lying down position is minimal, rather surprisingly, the veins remain sufficiently full to allow the aspiration of blood from them, to ensure that the needle point is really within the lumen It is

generally possible to make an injection into a vein safely and without difficulty while the patient enjoys a position of comfort and relaxation

Some assistance is available for keeping the vein filled by a tourniquet placed above the site of injection while the patient is standing The prone or supine position is assumed, the needle is inserted and when blood is freely withdrawn the band is released, a pause is made while the full veins subside and the fluid is injected. Care is taken lest the release of the constriction dislodges the needle point from the interior of the vein (Fig. 151)

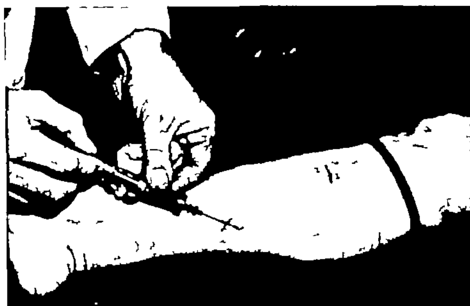


Fig. 151

Post-operative injection of veins (note scar of incision at knee). The leg is nearly horizontal, the selected vein has been marked with a cross, a light tourniquet is applied around the leg until blood appears in the syringe and verifies that the needle is in the vein the tourniquet is then released.

Clean and sharp needles are vital for effective and safe work The cause of failure to enter a vein may lie in the needle which may be blunt, and the soft vessel wall can be impaled on its point. A small fragment of blood clot may be in the needle cone from a previous injection

Injections in the standing position —When varices are injected in the standing position Kinmonth and Robertson found that the sclerosing fluid passed downwards towards the ankle In numerous veins about the ankle this factor can be made use of although they are often due to incompetent perforating veins above the ankle, when injections are useless and dangerous

Patients injected whilst standing frequently experience unsteadiness, apprehension sweating, fainting and giddiness on the whole it is a second best method, frequently ineffective and unsafe

Selection of varices —The prominent varicosities requiring injection are marked with a cross (+) on the skin in ink whilst the patient

is standing (the varicosities largely disappear when the patient sits or lies) The long arm of the cross is centred over the longitudinal axis of the vein and indicates the direction of the thrust of the needle The intersection of the cross is the point for the puncture

THE POSITION OF THE OPERATOR —The assumption of a comfortable convenient and relaxed position by the surgeon before each injection is valuable in giving that delicacy of touch that is essential for consistent safe injections, each one of which demands full attention The light must be good and the part easily accessible

THE INJECTION.

Skin preparation —The skin over the punctures is cleansed with iodine 1 per cent. in spirit The injections are made only where the skin is dry and healthy, and not into inflamed or eczematous areas

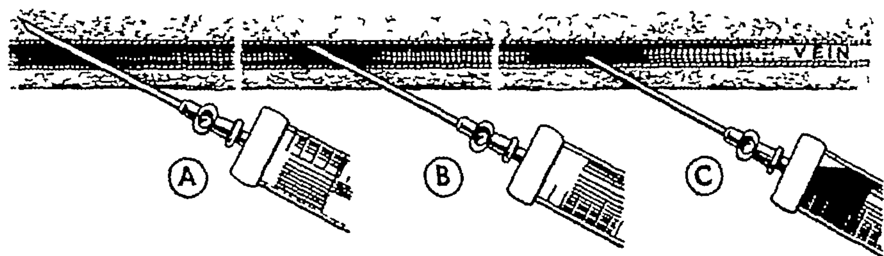


FIG 152

Technique of injecting a varicose vein.
A The vein is transfixed B The needle has been withdrawn whilst exercising suction C The needle is *in* the vein and has also been rotated to ensure that it is not half in and half out

THE PUNCTURE OF VARICOSE VEINS —The injection of a varicose vein differs from an intravenous injection in the arm where the veins are firm-walled and tense with blood Varicose veins are soft, thin-walled, often extremely mobile and but slightly filled When the needle point makes contact with them, as for the average injection, they contract, empty and flatten from the needle pressure and the prick Because they are tortuous and lie in fat, they may recede impaled on the needle point, without being punctured. Thus, to penetrate the varicose vein, a sharp needle resolutely directed is essential. The depth at which the veins lie is estimated and also their mobility; in the fat thigh this can be considerable

The plan one of us has practised for years is that of transfixing the skin and vein by one vigorous jab, while the skin over the vessel is steadied with the finger (Fig 152A) This quick thrust has the advantage of being almost painless, which is valuable for nervous patients, the quicker the penetration, the less is felt, usually only a touch The vessel is certainly punctured and it only remains to adjust the grip on the syringe to permit continuous aspiration as the needle is withdrawn, until blood appears in the syringe to ensure that the point is in the vein lumen (Fig 152B) As the needle orifice re-enters the

vessel blood appears in the syringe a pause is made, the hands are relaxed momentarily steadied and the suction is re-applied A further slight withdrawal or rotation of the syringe is often necessary to obtain a free flow confirming that the needle is in the vein and not half in and half out (Fig. 152c) The



FIG. 153

A. The vein to be injected has been marked with an X and the needle inserted. Note the leg is in the slightly dependent position. B The injection has been made and the leg is now resting on the couch.

injection is given slowly After five seconds the needle is removed and a swab is held lightly over the puncture to stop the temporary free bleeding (Fig. 153A and B)

A question arises with this "transfixion" technique "But doesn't some of the fluid leak through the puncture of the deep aspect of the vein wall? Possibly a little does but the swelling pain or after-effects that would suggest it have seldom been observed The injection being made slowly the puncture soon seals and it is easier for the fluid to flow along the vein lumen than through a small prick in the wall and so into tissues which offer more

resistance. When the needle is truly in the vein, the effort to effect the injection with a well-made syringe is slight and the plunger runs easily; when it is half in and half out, the increased resistance to make the insertion is discernible to sensitive fingers In addition, a swelling appears and the patient feels the pain which follows a paravenous injection of sclerosant

An air-bubble injection—A useful method when the injection is made in an upward direction is to have in the syringe a bubble of air ½ - 1 ml floating on the surface of the sclerosant When the insertion starts, the air goes in first and if the needle point is in the vein nothing happens, but if it is partly outside, then distension of the perivenous tissues follows and the position is corrected before any caustic fluid passes extravenously and perhaps irritates the vein into spasm, making re-entry difficult

If a swelling appears about the vein during the injection, it is the signal to stop and re-aspirate, for the injection is going paravenously Unless blood can be withdrawn, a new puncture is advisable

Very rarely blood may pulsate into the syringe, one of us has seen this three times, it may be due to a small arterio-venous fistula or to an artery being accidentally entered The injection is stopped and the clinical diagnosis reconsidered

THE FIRST INJECTION FOR SENSITIVITY—Enquiry is always made of patients concerning their previous experience of injections, especially regarding sensitivity to a substance The first injection of a sclerosant is a sensitivity trial, and is a single one and small in volume, say half the average dose, *i e* 0 5 - 1 ml The local and general effects are observed and noted If a person reacts to a solution, alternatives are tried, the allergy is explained to them in case treatment should be needed elsewhere, an anaphylactic collapse is thus avoided Quinine and sodium morrhuate require particular care in this respect

CUTICULAR SPIDER-LIKE VARICES—These are treated with caution. They are injected when they cause discomfort, as with those on the posterior aspect of the lower thigh which are rubbed when sitting, or when the possibility of a rupture threatens Tiny doses are given; the patient is warned of the possibility of an injection ulcer Generally, these varices are symptomless apart from their appearance A syringe 1 ml in size and an extra fine needle with a short bevel is used An aqueous solution of phenol 2 per cent glycerine 20 per cent is a safe agent for them, the dose is ½ ml In some instances it is possible to discern and inject the central draining vein The insertions are made weekly, with the patient sitting or lying, followed by an encircling *pressure* band of diachylon three-inch strapping for seven to fourteen days This treatment is efficient and trouble-free.

THE PLAN AND NUMBER OF INJECTIONS PER SESSION—The number of injections per visit depends on how many varices need treatment and the total safe dose of sclerosant The need is to avoid incapacitating the patient or

interrupting his usual activity It is our practice to mark out the veins requiring injection and to select three or four strategically placed ones to give the maximum effect. The total amount of any agent is limited to 8 ml The important veins (*e g* a patent portion of the internal or external saphenous trunk) are treated first. Injections are given leisurely with an interval between each and without the patient moving for five minutes afterwards When a vigorous painful reaction follows the dose is adjusted and only one or two insertions are made subsequently Incapacitation must be avoided to prevent the possible spread of the thrombosis deeply

Varices in the thigh generally take precedence over those in the leg, as varices fill usually from above downwards

After operation upon the internal and external saphenous veins, it is a matter of obliterating their residual superficial dilated tributaries These are usually but half-filled as their source of distension has been closed by the sapheno-femoral or sapheno-popliteal " tie "

Backflow from incompetent perforating veins must also be eliminated the larger ones require individual ligation but smaller ones may yield to accurately placed injections followed by a pressure pad and encircling band for a month. A hint of the whereabouts of incompetent communicating veins is given either by a " blow-out " in their neighbourhood by a cluster of varices, or by a shower of tiny sub- or intra-cuticular varices also the gaps in the deep fascia through which they pass may be palpable and tender on pressure These holes in the aponeurosis are sometimes more obvious in the supine patient with the leg raised for the veins empty and their grooves are palpable

When both legs require injection, it is a useful plan to do one per session this gives a person one sore limb at a time

Prominent veins about the ankle and dorsum of the foot —These are often only eyesores and cause little trouble When the radical operation and stripping has been done followed by sclerosis of the remaining varices in the leg, these lower vessels frequently disappear in the subsequent year

Should they persist they may be injected by the technique already described. They are not easy to puncture because they are mobile, but with a sharp needle and the " *stab* " *technique they can be treated successfully They* are dressed with a pressure pad held with a circle of strapping round the foot or ankle for two weeks It is repeated that varices higher in the leg, *e g* the anterior tributary of the internal saphenous vein, may be filling those in the foot—these are sclerosed first.

Notes —Accurate notes and diagrams of the site volume and number of injections are made rubber stamp outlines of the leg are convenient. The constitutional and local effects are inquired of the patient and the area is inspected so that an estimate may be made of the response and further dosage. Especially with older patients is alertness necessary because their tissues will not stand the reactions that can occur with safety in those younger

ally there is hyperaemia of the skin. If the pain is marked, a compress of glycerine and belladonna firmly bandaged will give some relief

After the fourth or fifth day the local swelling and tenderness begin to subside. In one to three weeks the sensitiveness disappears and the solid vein continues to shrink for three or four months (occasionally longer) and finally disappears. The brownish discoloration over its course may persist indefinitely although with time it fades.

During the first few weeks there may be some dragging feeling in the leg In the external saphenous vein this is because it is intimately associated with the deep fascia.

CONSTITUTIONAL EFFECTS —The good sclerosant must have few or no constitutional effects It has been seen that toxic systemic effects and possible thrombosis of the deep veins are possible complications An urticarial skin rash may follow injections Adrenalin (1 in 1 000) 5 10 minims intra muscularly will give relief to allergic reactions and it should always be at hand where sclerosing injections are being given

Occasionally there are faintness and giddiness during and after the injec tion. Some are psychological The sitting or reclining position is ideal for the minimum of adverse effects Rarer still an anaphylactic collapse with vomit ing, spontaneous micturition and defaecation occurs and more seldom death These sequelae have occurred after sodium morrhuate and after an excessive dose of sodium salicylate. Patients as a rule respond to symptomatic remedies adrenaline 5 10 minims is injected intramuscularly should collapse take place

The incorporation of 1 minim of adrenaline (1 in 1 000) with each millilitre of ethanolamine to prevent adverse constitutional reactions is note worthy

The sitting or supine position the volume of sclerosant limited to 1 2 ml. with a three to five-minute rest before moving, is the best prophylactic for reactions which are extremely rare.

Complications after sclerosing injections

PAIN AND INCAPACITATION —The chemical phlebitis following the insertion of a sclerosant must not be too severe and incapacitate the patient either at the injection from venospasm or later Salicylates and saline 20 30 per cent cause a painful venospasm. Lithocaine quinine and urethane given separ ately or together as a " twin " injection and Ethamolin are followed by severe painful thrombophlebitis for one to ten days and for this reason are not used routinely

EXTENSIVE CHEMICAL PHLEBITIS —Massive thrombophlebitis occasion ally follows an injection it alarms and possibly incapacitates the patient. The operator usually regards it as a good result, and gives a confident assurance After the internal saphenous trunk has been injected instead of a portion of

vein being involved, spreading phlebitis occasionally follows and the thrombosis may extend from the saphenous opening to the ankle Such a result is unusual Local and general sedatives are prescribed, a pressure bandage is applied from the ankle to the groin, and normal activity as far as possible is urged

If the internal saphenous vein is incompetent, an early sapheno-femoral ligation should be advised

NECROSIS OF THE WHOLE VEIN WALL —When concentrated solutions have been used in an empty vein the whole vein wall may be damaged, and the sclerosing substance may effect the surrounding tissue When this occurs with quinine, the pain felt at the time persists longer and increases subsequently. The indurated area does not invariably break down and can sometimes be resolved without sloughing An Unna's paste bandage firmly applied may avert such a complication When a salicylate solution is the sclerosant, the chance of avoiding necrosis is less

The same risk is incurred if " ordinary " strengths are used for thin-walled cuticular veins A weaker solution (phenol 2 per cent, glycerine 20 per cent) limited to 0 5 ml will avoid such ill-effects

INJECTION ULCER —Many injection ulcers have occurred after paravenous injections of quinine and urethane, concentrated saline and sodium or lithocaine salicylate The safe agents in this respect are the phenol-glycerine solutions, and ethanolamine

Areas of ischaemic tissue-necrosis around the injected vein occur and require up to three months to liquefy, resolve and heal, usually leaving a depressed pigmented scar Shelley (1939) and Barrow (1949) advise the immediate surgical excision and suture of these necrotic areas because a quicker and less painful recovery follows When the injection is seen to be paravenous, firm massage of the areas assists the dispersal As necrosis is prone to occur in scarred and pigmented areas about the lower third of the leg and in the aged, injections are not given in these cases

Selective and accurate work is the sovereign remedy to avoid injection ulcers, and most important is the prompt realisation that if the needle is not in the vein, of stopping and trying again, then or on another day The signs of an extravenous injection are *pain*, the resistance to the plunger whilst giving the injection, and swelling about the vein Their appearance arrests the insertion and the whereabouts of the needle-point is re-determined by aspiration At least one re-aspiration should be made during each injection, this eliminates painful induration and possibly ulceration, and assists its maximum effect and safety Necrosis-producing agents are used with vigilance and only after the phenol-glycerine solution has failed to sclerose The more caustic sclerosants are permissible with a large varix, *e g* a large tributary of the long saphenous vein after sapheno-femoral ligation in which the injection can be made with certainty, followed by the pressure bandage for two weeks

When a perivenous injection occurs the remedy is to aspirate as much as possible and to inject the area immediately with 2 5 ml of saline or procaine ¼ ½ per cent and to re-aspirate The sclerosant is thereby diluted and tissue death may be avoided.

LOCAL SWELLING OF THE LEGS —Local swelling of the legs can follow the injection of varicose veins This may be due to a paravenous injection, sepsis with and without cellulitis, or an excessive chemical thrombophlebitis The last is not infrequent after the twin administration of lithocaine with quinine and urethane.

Some patients are sensitive to the sclerosing agent and excessive local swelling occurs. Thrombosis of a perforating vein is a possibility with ensuing muscle swelling and cramps The swelling usually subsides in a week A general swelling of the foot and leg indicates the presence of deep thrombosis.

CRAMP IN THE LEG —Cramp at the time of the injection is generally mild and passes off in a few seconds If a severe cramp persists in the calf for a longer period and particularly if it is followed by oedema of the foot and leg, it is assumed that the solution has affected the intramuscular veins *or possibly the deep veins* and the appropriate remedies are instituted (*see* Chapter XII) The oedema usually clears in a fortnight damage to the closely valved venae comites and lower leg communicating veins will show in the following years

Sedatives are given to relieve the pain generally and locally Glycerine and belladonna are applied to the painful part, and a 3½-inch elastic webbing bandage is applied tightly from the toes to the groin and re-applied morning and evening to take up the slack of wear and tear and of the subsiding oedema. *The patient is urged to keep about and, when resting, to elevate the* limb above the horizontal by raising the foot of the bed Analgesics *e g* codeine, or papaverine gr 3 with quinine hydrochloride grains 5 10 orally will relieve the muscle cramps

If the swelling spreads or is exceptional and involves the whole limb this would indicate expensive deep thrombophlebitis (Chapter XII)

Thrombosis of the deep veins after sclerosing injections into superficial varicose veins was seen fairly often by one of us on taking over a varicose vein clinic in which promiscuous, large and repeated injections into grossly incompetent varicose veins had been given It is a dire complication and its possibility and long term disability merits emphasis as does the uselessness of sclerosing injections in such patients.

SENSITIVITY RASH —In over twenty years of injection therapy one of us has seen a sensitivity rash only on two occasions both were transient. An immediate injection of adrenalin minims 5 10 (hypodermically) may quickly reverse the process The application of lotio calamine containing 1 2 per

cent phenol assists; failing this, the substitution of ichthyol 1 - 2 per cent for the phenol is useful An antihistamine drug by mouth is invaluable in relieving the itching by day and night and assisting its resolution

SEPSIS AT THE SITE OF INJECTION —Injection therapy for varicose veins is a service of convenience It is given only when aseptic technique is available Septic injections are exceedingly rare An infection could be introduced by the puncture in an eczematous or inflamed area, and cellulitis may develop, but injections are not given in such parts

The infection is treated by parenteral antibiotics and soothing local applications Incision is seldom needed, but is made promptly should fluctuation be detected, the pus is cultured and the appropriate antibiotic is prescribed A sapheno-femoral or sapheno-popliteal ligation and division of the saphenous trunk may be needed prophylactically to limit a spreading septic saphenous thrombosis

SUPPURATIVE PHLEBITIS —Shelley (1939) reports one case of suppurative phlebitis following a sclerosing injection This was due to the presence of an ulcer not sufficiently cleared up before the injection was made The patient died of a resulting *staphylococcus aureus* septicaemia, although the affected vein was excised after ligation above the involved area

LATENT THROMBOPHLEBITIS —Another reaction is the lighting up of an unsuspected latent thrombophlebitis This is never a serious complication if the patient is kept ambulant and the leg given adequate pressure support

If injections are given in the presence of an active superficial phlebitis (as one of us does), the patient must be ambulant and the leg continuously pressure bandaged No ill-effects have been seen after such treatments

DELAYED THROMBOPHLEBITIS AFTER INJECTION.—The phenomenon of spontaneous painful thrombophlebitis several weeks after sclerosing injections is occasionally seen The area is usually below that where the treatment was given It is often severe, with pain, redness, heat, swelling and difficulty in walking As it arises without an apparent cause, it provokes considerable alarm in the patient

The sequel has been beneficial, being followed by obliteration of the affected veins It is treated by a pressure bandage or strapping (Diachylon) for two to three weeks and sedation as required

CALCIFICATION OF THROMBOSED VEINS —One patient has been seen with an ulcer of the ankle with a calcified yet recanalised long saphenous vein ten years after the injection of caustic soda as a sclerosant

Another patient was seen in April, 1953, with a calcified but recanalised external saphenous trunk

Failed sclerosis and recurrences after sclerosing injections

FAILED SCLEROSIS.—Some varices fail to sclerose after several injections this is probably because of the retrograde flow and high pressure within them The diagnosis may be wrong and must be reconsidered. Further ligation perhaps of a faulty communicating vein may be required. The temptation to use stronger sclerosants in greater volume is resisted the correct diagnosis is the essential not more and possibly dangerous insertions threatening the deep veins and the patient's well-being

The intima of some varices may be resistant to a sclerosant and a trial is made of other remedies *e g* quinine lithocaine ethamolin with the usual preliminary small dose to test the patient's sensitivity

Some varices are old their walls are thickened and fibrosed, and they normally gape open. To close these permanently by injection after the strategic "tie" requires continuous pressure on them with a pad and Diachylon strapping.

If there is a special reason for persistence with the injections a "twin" injection of lithocaine 1 5 ml and quinine and urethane 1 5 ml. is made with the patient sitting or lying down and remaining so for five to ten minutes afterwards Before moving from the couch the limb is dressed by a Diachylon pressure bandage which is worn for two to four weeks to flatten the vein walls into apposition The patient, of course, resumes normal activities forthwith.

RECURRENCES.—In our experience recurrences or recanalisations are certain when there are inefficient terminal saphenous valves the external saphenous is more likely to be overlooked. If these are not present, and patients return, it is usually with new varices, or a defective communicating vein somewhere, especially above the ankle If the varices are small to modest and are properly selected recanalisations are rare when they do occur the diagnosis is reconsidered for varicosis is a progressive malady

On several occasions when reviewing the diagnosis we have found an unnoticed varicose external saphenous vein after a sapheno-femoral ligation and injection of the internal saphenous vein and occasionally the reverse In some persons operated on by us and others one or other of the saphenous veins which had already been dealt with operatively had re-opened because a *terminal tributary had been missed* and through it the *high deep venous* pressure had passed again. Re-operation was therefore necessary

To a lesser extent incompetent communicating veins have been found requiring ligation

The importance of a trustworthy operation technique of a flush terminal saphenous ligation is repeatedly being stressed in our follow-up clinics, otherwise recanalisation is inevitable in any vein subject to the high pressure of the deep veins, which may rise to 200 mm Hg during straining.

An evaluation of injection therapy.—An accurate diagnosis of the varicose veins is the prerequisite to effective treatment which must be correctly selected; injection or operation or a combination of both may be required Correctly used, injection therapy is rewarding

SUMMARY

1 The indications for sclerosing injections are the small trivial or "vanity" veins and for residual outlying varices after the operations of ligation and stripping of the varicose saphenous trunks (Chapter VIII)

2 Phenol-glycerine solution is a safe effective sclerosant

3 The patient must sit or lie down during the injection and should continue so for three to five minutes

4 The maximum volume per injection of any sclerosant is 2 ml, two to three such insertions may be given per session

5 Continued pressure to the injected varices is advisable for two to three weeks to minimise the resultant thrombosis, to flatten the sclerosed veins and to facilitate their organisation.

6 Sclerosing injections are given only to active persons; movement is the best safeguard against deep or communicating vein thrombosis

(7) *Sclerosing injections are never given to patients with untreated incompetence of the internal or external saphenous veins or of the communicating veins, especially those at the ankle in such circumstances they are useless and dangerous.*

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CHAPTER VIII

THE OPERATIVE TREATMENT OF VARICOSE VEINS

THIS chapter on the operative treatment of varicose veins is based mainly on our personal experience We have concentrated on clinical diagnosis and performed many operations We have seen the majority of these patients before and after operation The chart showing the patients operated on by one of us giving the various diagnoses may be of interest in suggesting the frequency of the varicose presentations The numbers of recurrent varices, those occurring during pregnancy, inefficient communicating veins, and procedures for ulceration may be relatively high, because they presented problems and an opportunity for study

The table on the following page analyses the patients operated on by one of us in a five-year period It indicates their variety and approximate proportions

Operations for varicose veins and their associated conditions are in our opinion important, and merit the attention of all members of a general surgical team The practice of deputing the diagnosis and treatment entirely to juniors is deprecated.

The procedures exact high standards of diagnosis, investigation and technical skill and are rewarding in their results They are excellent training for other major operations, which often occupy the senior surgeon but which do not always contribute so much to the well-being of the patient and community

Review of operations performed for varicose veins, 1927-53.—The following are the types of operation which one of us has performed for gross superficial varicose veins during the period 1927 to 1953 They are detailed so that procedures which have been found to be inadequate may be known because at present the treatment of varicose veins differs widely from surgeon to surgeon and is seldom based on a five-year follow-up of patients operated on.

1. 1927 Ligation of the internal saphenous vein "somewhere" in the groin, no attempt was made to divide the terminal radicles or to locate the sapheno-femoral union It was done to assist healing of grossly ulcerated legs; combined with rest in bed It was often successful, but no follow-up was done The attitude then was, "varicose ulceration a tiresome condition!"

2 1932 Terminal saphenous ligation combined with retrograde injection of the sclerosant quinine and urethane 3 - 5 ml into the internal saphenous vein through a hypodermic needle This proved to be a step forward; it was not new, of course—Tavel was doing it in 1904 Its effect on the saphenous trunk and tributaries was an unpredictable amount of thrombosis It combined the older remedy of ligation with the newer one of sclerosing injections

		Males	*Females*	*Total pts*	*Total limbs*
Internal saphenous	474				
	Right	49	83	132	
	Left	46	97	143	
	Bilateral	61	138	199	
				—474	673
With eczema	Right	—	2	2	
	Left	1	4	5	
	Bilateral	3	7	10	27
				— 17	
With ulcer	Right	6	13	19	
	Left	13	13	26	
	Bilateral	5	18	23	91
				— 68	
With pregnancy	Right	—	2	2	
	Left	—	6	6	
	Bilateral	—	7	7	
	Bilateral c ulcer	—	2	2	26
				— 17	
				576	817
External saphenous	66				
	Right	12	18	30	
	Left	7	16	23	
	Bilateral	4	9	13	79
				— 66	
With eczema 2	Right	—	1	1	
	Bilateral	—	1	1	3
				— 2	
With ulcer 3	Right	2	1	3	3
				— 3	
With pregnancy 1	Right	—	1	1	1
				— 1	
				72	86
Internal & external saphenous 20					
R.i.s. & e.s.		2	—	2	
L.i.s. & e.s.		—	2	2	
L.i.s. & e.s. with ulcer		1	—	1	
R.i.s. & L.e.s.		2	2	4	
R.i.s. & L.e.s. with ulcer		—	1	1	
L.i.s. & R.e.s.		3	3	6	
R.i.s., L.i.s. & e.s.		—	1	1	
L.i.s. & e.s., R.e.s.		1	—	1	
R.i.s. & e.s., L.e.s.		—	2	2	
				— 20	
Communicating veins	11	1	10	11	
				— 11	
Re-operation on recurrent or persistent veins after operation.		39	29	68	
				— 68	

i.s. = internal saphenous vein.
e.s. = external saphenous vein

3 1937 Ligation, division and injection of the internal saphenous vein above the knee was added to the procedure in the groin because varices persisted in the leg after procedure No. 2.

4. 1938 The "twin" injection of lithocaine 3-5 ml (*see* Chap VII, p 166) and quinine and urethane 3-5 ml. was substituted for the quinine and urethane because it was a more potent sclerosant This too was given at the groin and at the knee The sapheno-femoral junction was specifically sought and ligated.

5 1940 All the terminal tributaries of the internal saphenous vein were tied and divided in addition (Dodd and Oldham, 1940) The retrograde injections at the groin and knee were continued

6 1941 Sapheno-femoral ligation and a needle ten inches long with a pear-shaped tip (a development of Lang-Stevenson's needle) was inserted retrogradely into the internal saphenous vein from the groin, and this enabled the sclerosant to be distributed evenly between the knee and the groin The extent of the chemical phlebitis was larger and more controllable

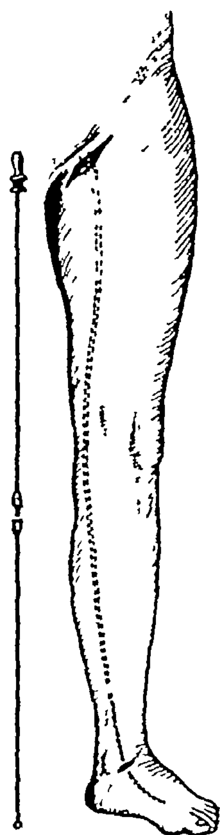


Fig 155
The extending needle

7 1941 Ligation of the internal saphenous vein at the ankle was substituted for that at the lower thigh and a catheter was threaded up it to the knee; the aim was to distribute the sclerosant along the whole of the saphenous trunk with the object of destroying it and its tributaries

8. 1942 (*a*) Saturated sodium chloride (30 per cent) was used as a sclerosant instead of quinine and urethane and lithocaine, because it was considered to be constitutionally safer, although no accidents had occurred with the former. The dose of salt was gradually increased to 40 ml. at the groin and 30 ml. at the ankle An extending needle was made which occasionally carried the injection down to the ankle, so avoiding the second incision there (Fig 155)

(*b*) The potency of incompetent communicating veins, especially in the lower third of the leg, was realised and these were sought for when ulceration persisted after operation 8*a*

1946 "Saphenectomy"

(*a*) By abrasion and sclerosants —In October, 1946 (inspired by Riddoch of Birmingham), in order to destroy the saphenous trunk more certainly, its interior was abraded by a curetting needle threaded into it from the groin and the ankle, followed immediately by an injection of concentrated saline as a sclerosant (Fig 156) In January, 1947, Riddoch's solution—phenol 2 per cent , glycerine 30 per cent in water—was introduced as a sclerosant (The concentrated saline was discontinued because it had occasionally caused sloughing of the fat and skin over varices) Over 700 patients were treated by curetting and

sclerosant injection with 90 per cent. of satisfactory results but there was a proportion of persistent varices and recurrent ulceration in spite of follow up injection care these were nearly all due to incompetent communicating veins

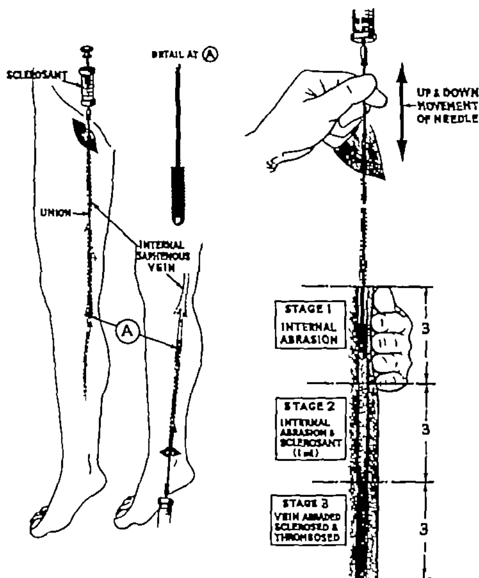


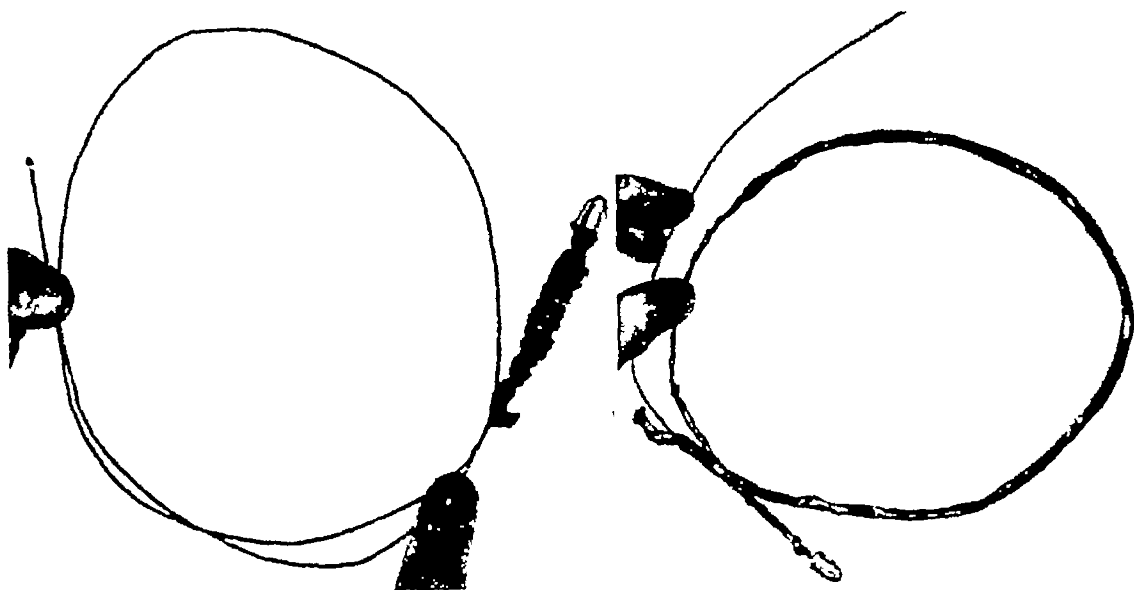
FIG. 156
The abrasive needle for internal abrasion and injection of varicose veins.

at the ankle, knee or mid thigh. This procedure we call "saphenectomy *in situ*"

(*b*) BY STRIPPING.—From 1949 to December 1951 stripping of the internal saphenous trunk and less often of the external saphenous vein was used occasionally instead of curettage and injection. It was done for experimental reasons In January 1952, "saphenectomy" by "stripping" (Figs 157 and 158) was started in all cases to compare it with the preceding five year series of "saphenectomy" by abrasion and sclerosants The stripping

followed sapheno-femoral or sapheno-popliteal ligation, and the division of faulty communicating veins

The last two methods, *i e* saphenectomy *in situ* and saphenectomy by stripping, have been found to be the most satisfactory after three to eight years follow-up *Stripping* is in our opinion the better of the two, and we prefer and advise it.



FIGS 157 and 158
An internal saphenous vein stripped , telescoped and opened out

HISTORY OF STRIPPING

The operation of stripping was introduced by Mayo in 1906, as a variation of Keller s operation (1905) of extirpation of the saphenous trunk by threading a wire through it Mayo threaded the saphenous vein into a loop on a steel shaft (Fig 159) which he passed along the outside of the vessel as far as possible down the thigh (Fig 160) He then cut down on to the end of this stripper through a small incision and took out the mobilised vessel The

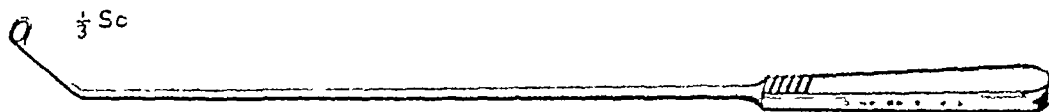


FIG 159
Mayo s stripper (*By courtesy of Down Bros*)

following year Babcock (Fig 161) modified Mayo's method by inserting a long probe with knob on its end down the saphenous trunk He took out considerable lengths by ligating the vessel round the bulbous tip of the probe, cutting it and pulling it out either by inverting it or telescoping it on the stripper

About this time the treatment of varicose veins by the terminal saphenous ligation and retrograde sclerosing injection was introduced It was generally adopted and " stripping ' fell into disuse

In 1945, the complications and limitations of the " ligation-injection method " led Hodge, Grimson and Schiebel to re-evaluate the " stripping ' technique They reported 195 operations and followed up 102 patients from ten to twenty-seven months , 71 patients were greatly improved 24 moderately improved, 7 unimproved , *i e* 95 out of 102 were good results There were no operative or late deaths and no pulmonary complications , half the patients developed new but small varicosities during the period of follow-up

In 1947 McElwee and Malsel reviewed 365 unselected cases of varicose veins treated by five operative techniques between the years 1940 1944 288 were followed up for at least a year the average being eighteen months. The methods used were —

High ligation	103
Multiple ligation	121
High ligation and retrograde injection	103
Stripping	104
High saphenous ligation and excision of varix	21

Fig. 160
External stripping by a Mayo's type of stripper

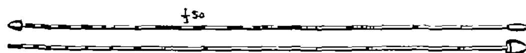


Fig. 161
Babcock's stripper
(*By courtesy of Down Bros.*).

Satisfactory results followed in 79 per cent., the best being obtained with multiple ligation high ligation with injection, and "stripping," in that order "Stripping" necessitated the longest stay in hospital although the complications following it were trivial consisting of one haematoma, one superficial phlebitis, two superficial wound infections and one (?) pulmonary embolism—the only one in the series. Complications were more numerous after multiple ligation and more severe after ligation-injection. Stripping gave good results, but the need for a general anaesthetic made it at that time a more severe operation, and the conclusion drawn was that multiple ligation was the method of choice.

In 1949 Linton reported that because of the recurrences following ligation-injection therapy, he had tried a combination of ligation and "stripping" in 500 cases There were no deaths and only one case of deep thrombosis after the operation. He considered that the post-operative care was important, his patients were ambulatory with elastic support on the first post-operative day, but were not allowed to sit on a chair for a week As a rule, subsequent injections were necessary and occasionally some further surgical treatment This report gave no indication of the length of follow-up of cases In 1950 Thompson in England reported his modification of the Mayo stripper Quattlebaum (1950) reviewed the procedure and stated that the operation was safer than retrograde injection and ligation, but he gave no figures

Foote (1949) quoted the mortality figures for stripping given by Bernsten (1927) (embolism 7 2 per cent, death 0 7 per cent in 376 cases) and Anschutz and Löhr (1929) (death 0 5 - 1·0 per cent.), and stated that in view of the good results which could be obtained with careful ligation and injection, stripping was not justifiable, but he has since become an enthusiastic user of this method (1954)

Myers and Cooley (1954) followed up 100 patients with varicose veins and post-thrombotic legs, for upwards of six years They were treated by sapheno-femoral or sapheno-popliteal ligation, division of the terminal tributaries and, since 1948, stripping Incompetent communicating veins were ligated subfascially. They state, "We are of the opinion that not only does vein stripping offer a much more complete and thorough procedure, but that the results are better after this operation At present, all of the operations performed on varicose veins at the Mayo Clinic consist of extensive stripping of the involved veins and ligation of incompetent perforating veins with special attention to the distal third of the leg A flexible intra-luminal stripper as designed by one of us (Myers) is used for this operation"

Comment—From the reports of Hodge *et al* (1945), Linton (1949) Quattlebaum (1949), Carter (1954), Myers *et al* (1954 and 1955), Kinmonth (1955), Dodd (1955), it is apparent that stripping is an effective step in the treatment of gross varicose veins

Selection of patients for operation.—If the general health is good, the diagnosis of gross varicose veins firm, and the patient's need is clear, the radical operation is offered to all persons, irrespective of age The youngest patient we have treated was eight years old, the oldest eighty-two Two cooks aged seventy-six, with varicose veins and ulcerated legs, received saphenous ligation and injection, and returned to work much relieved in three weeks Many other septuagenarians who were gainfully employed have been treated with satisfactory results

In older people, the possibility of peripheral arterial disease and defective deep veins is considered before advising operation on the varicosities, especially in those with cold, thin-skinned, scarred, ulcerated, eczematous, stiff or wasted legs and feet The possible presence of cardio-circulatory disease, diabetes, renal disorders, anaemia, etc, is also checked When ulceration and eczema are the complaints causing an older person with varicose veins to seek medical aid, care is taken to make an exact diagnosis, for although the varicosities are contributory, the other factors mentioned may be as important as the incompetent veins

If the veins are inefficient, and if they are interfering with the patient's activity, then their treatment is justified, but some degree of activity is a *sine qua non* before therapy is advised

The treatment, besides relieving discomfort, will reduce future complications, especially thrombosis, during other immobilising illnesses. The elderly can be operated on under local analgesia All patients get up as soon

as they are sufficiently recovered from the operation *i e* the same day Early walking in compressing bandages is encouraged

"A frequent question."—Many patients advised to undergo an operation for their varicose veins ask how the circulation in their legs can be carried on after the obliteration or removal of the affected veins The explanation to the patient is that varicose veins are by their nature degenerate and ineffective vessels, and a compensatory venous return by efficient veins has been established by the time treatment is sought Varicose veins are a burden on the venous circulation, and in the upright position contain blood which is not in useful circulation it is either static in the varices or part of a "private" circulation from the deep to the superficial veins and back again The obliteration of such vessels eliminates their harmful hypertension

A previous white leg.—When there is a history of a "white leg" and the deep venous return is defective the question of operation on superficial varicose veins must still be considered In the past the teaching has been that operation should not be performed The crux of the matter is that a superficial varicose vein, by its failed valves, cannot normally make a useful contribution to the venous return, and is adding to the patient s difficulty in returning blood from the lower limbs. Therefore the sooner clearly incompetent superficial veins are dealt with the better Usually nothing more than ligation of faulty communicating vein or veins and a good elastic stocking is required

In our opinion the trunks of the varicose internal and external saphenous veins should not be stripped When these vessels are clearly incompetent then the sapheno-femoral and sapheno-popliteal junctions should be ligated and divided and incompetent communicating veins tied. This eliminates the high pressure leak but leaves the superficial venous channels in case the deep thrombosis recurs. Stout elastic stockings continue to be worn.

Technique.—For operations on varicose veins impeccable asepsis is required for consistent healing by first intention Good assistance a properly equipped theatre and the necessary special instruments (Fig. 162) are essential The procedure is often referred to as "only varicose veins," and inexperienced personnel with insufficient equipment frequently undertake it, with occasional dire consequences to the patient, *e.g* sepsis injury or division of the femoral vein or artery deep thrombophlebitis etc The precedure needs a good deal of sterile linen, for the *entire* patient is towelled off (Fig 163) Low-grade cellulitis and dermatitis readily develop after this operation possibly from tearing infected lymphatics but mainly we think from an inadequate surgical layout. Healing of such infection may take up to three months, especially in the obese sepsis in the groin in these fat patients may be especially tiresome.

Operation according to diagnosis.—The various clinical presentations of superficial varices requiring operative treatment are as follows —

1 *The incompetent internal saphenous vein*—This is ligated at the sapheno-femoral union and ankle and the saphenous trunk between these two points is removed by stripping

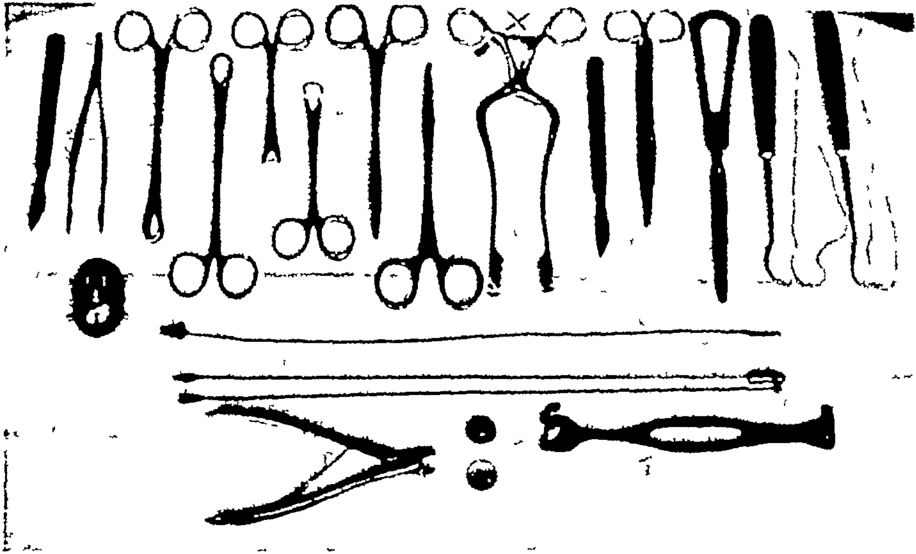


FIG 162
The instruments for a varicose vein operation, note the self-retaining retractor



FIG 163
A limb towelled for an operation on the internal saphenous vein

2. *The incompetent external saphenous vein*—This is ligated at the sapheno-popliteal union and at the external malleolus, and the intervening vessel is excised by stripping

3 *The incompetent communicating vein or veins in the leg or in the thigh* require location ligation and division The gross subcuticular varices adjacent to them may be injected with a sclerosant, or excised.

4 Simultaneous *varicosis of the internal and external saphenous veins* these require treatment as in 1 and 2.

5 *The faulty internal saphenous vein* with a *defective communicating vein* in the thigh or ankle is treated by ablation of the former and division of the latter

6 *The defective external saphenous and communicating veins* are treated as in 2 and 3

7 The triple combination of varicose internal and external saphenous veins together with *defective communicating veins* is relieved by ligation and division of all three, with ablation of the saphenous trunks

8 *Recurrent varicose veins* usually include one or more of the above, and are treated accordingly

Thus, the three operations advised for varicose veins are those of —

1 Ligation and division of the sapheno-femoral junction, with saphenectomy of the long saphenous vein from the groin to the ankle by stripping.

2. Ligation and division of the sapheno-popliteal union, saphenectomy of the varicose short saphenous vein from the popliteal space to the ankle by stripping.

3. The ligation and division of a faulty communicating vein or veins located usually in the lower third of the leg or thigh. The act of stripping does *not* necessarily destroy incompetent perforating veins.

Ligation and division of the great saphenous vein at the groin and its ablation to the ankle is the commonest operation the external saphenous vein is incompetent in about 9 per cent. of cases (Slevin 1948) In a personal series there were 1,303 patients with internal saphenous incompetence 137 with external and 46 with both internal and external varicosities. Failure to detect inefficiency in the short saphenous vein or the ankle perforating veins has been a cause of persistent varicose veins eczema and recurrent ulceration especially of that situated around the external malleolus The following is an all too typical case history

Mrs. M S., aged 50 was first seen in May 1947 when she complained of varicose veins of the left leg with gross ulceration at the external malleolus. The *tourniquet test revealed* an incompetent internal saphenous vein, and on 6/6/47 the operation of ligation abrasion and injection was carried out at the left groin and ankle By 27/6/47 the ulcer was healed and the leg improved although requiring a few *further injections*. The ulcer recurred at the end of August, but with Lestreflex bandaging it was healed by October 1947 In October 1948 re ulceration occurred following a knock, *and incompetence* of the external saphenous vein was diagnosed after a little difficulty as it was obscured by an enlarged semi membranous bursa. Injections were made into this vein on two occasions The ulcer recurred in January 1949 and a "twin" injection was given into the external

saphenous vein on 3/3/49 The ulcer, however, did not disappear completely and in April ligation, abrasion and injection of the external saphenous vein was carried out By 7/7/49 the leg had recovered, and it remained well until in January, 1954, following a kick on the ankle, the ulceration re-appeared over the external malleolus, which healed with compressive bandaging. In May, 1954, the supra-malleolar areas were explored for inefficient communicating veins, the middle internal perforating vein was found enlarged and defective, it was ligated When seen in July, 1955, the result was perfect, but as she is over fifty years, faithful care and protection by a robust elastic stocking was emphasised This tedious story could have been avoided by a complete diagnosis and operation when she was first seen

OPERATION FOR SUPERFICIAL VARICOSE VEINS

The operative treatment advised for varicose saphenous veins consists of their permanent disconnection from the source, or sources, of high pressure filling from the deep veins and the destruction of their trunk and grosser tributaries These aims are achieved by :—

(*a*) **Terminal ligation.**—The superficial varicose system is ligated and divided precisely at its deep connection with the high pressure filling source, *e g* by a sapheno-femoral or sapheno-popliteal ligation. Less frequently the venous hypertension is conveyed by an inefficient communicating vein or veins between the superficial varices and the deep system in the thigh or leg, and these must be located, ligated and divided *This ligation procedure to eliminate the high pressure filling is fundamental; the other steps which aim to destroy the varicose saphenous trunk and its tributaries are subordinate and complementary to it* The division of an incompetent communicating vein above the ankle is usually necessary when swelling, ulceration or eczema are, or have been, present or threatening

(*b*) **Elimination of the saphenous trunks.**—The main stems of the long and short saphenous veins must be destroyed This is achieved by the technique of total extirpation by stripping

If this obliteration is omitted, these defective trunks and their tributaries fill with blood from other venous sources They are an eyesore and a possible site of thrombophlebitis Although they are disconnected from their proximal high pressure venous filling by the terminal saphenous ligation, they refill from normal veins as well as other points, *e.g* inefficient communicating veins present or future Perforating vessels vary in size, number, situation and efficiency. It is impracticable to divide all of them individually, nor is it necessary to do so. It is only the large relatively constant direct perforating veins which need ligation when they become incompetent.

SAPHENECTOMY BY STRIPPING —The saphenous trunk is entirely removed from its source to its termination by tearing or telescoping it out of its bed with an instrument called a vein stripper (Figs 157 and 158)

SAPHENECTOMY IN SITU.—This consists of the dual step of threading a long needle with an abrasive head into the saphenous trunk with which the intima of the vein is curetted followed by the insertion of small amounts of a sclerosing fluid (Fig. 156)

Evaluation of saphenectomy by stripping and saphenectomy in situ.—We have practised stripping and also 'saphenectomy *in situ*' Effective instruments for each are available Preceded by an accurate diagnosis and efficient terminal ligation they yield excellent long-term results Each surgeon will choose his method, but in doing so he will realise that it is subordinate to an exact diagnosis and division of the site or sites of abnormal hypertensive filling

Internal abrasion and injection was reluctantly discontinued for stripping by one of us The growing reputation of the latter procedure led us to evaluate it by doing a series of such operations, beginning in 1951 The results after four years (over 500 operations) are excellent Fewer post-operative injections are required after stripping than after saphenectomy *in situ* Therefore we recommend stripping.

Four long tributaries remain after stripping of the long saphenous trunk (the postero-medial and the antero-lateral veins in the thigh and the posterior arch and anterior veins in the leg) These often shrink to inconspicuous proportions, thrombose spontaneously or persist obviously varicose in which case they are injected at the follow up visits (Fig. 190)

THE ANAESTHETIC

General anaesthesia is preferable for the radical operation for varicose veins. It can however be done under local anaesthesia if for any reason general anaesthesia is undesirable

The following case report (one of several such patients) illustrates its value —

A woman of forty-eight had established mitral disease with gross bilateral saphenous incompetence and with pre ulcerous and eczematous changes at the ankle. Her physician said a general anaesthetic was dangerous, and he wished her to continue to be active in her home. She did not tolerate elastic stockings. Her leg condition was largely immobilising her The veins of each leg were tied and stripped under local analgesia at a week's interval She felt no discomfort during the operation and recovered well. She is remarkably improved constitutionally and in the comfort and function of her legs

The main disadvantages of local analgesia are the mental strain imposed upon the patient (and sometimes on the surgeon and surgical team)

A further step to avoid pain during operations under local analgesia is that of inducing sleep at the painful stage of the procedure by injecting enough

thiopentone to cause unconsciousness immediately before the stripping is carried out.

Prior to operation performed with local analgesia, patients are made physically and mentally comfortable by an adequate pre-anaesthetic given one and a half to two hours before the expected time of operation Omnopon gr 1/3, scopolamine gr 1/150, and one or two tablets of Evidorm (Bayer) (hexobarbitone gr 4 and cyclobarbitone calcium gr $\frac{1}{2}$) is a good premedication If necessary, should the patient not be sleepy, a further injection of omnopon gr. 1/3 can be made an hour later

Martorell (1951) is enthusiastic and insistent about the suitability and necessity of local analgesia for the operation of ligation of varicose veins, to avoid the complication and danger of deep thrombosis and embolism

LOCAL ANALGESIC MEDIA

(*a*) *Procaine* $\frac{1}{2}$ - 1 per cent with 2 minims of 1 in 1,000 adrenalin solution to 1 oz of Procaine is excellent It is safe, it acts immediately, and is effective for one hour, which is ample for the procedure

(*b*) *Xylocaine*—1 in 200 to 300 aqueous solution also with adrenaline 1 in 1,000 is likewise an excellent analgesic, with a prolonged action, suitable for an operation for recurrent varicose veins

Hyaluronidase (Hydase, Rondase) added to the analgesic assists its rapid diffusion, and assures an insensitive field.

Sterility of the analgesic.—To ensure asepsis and perfect healing, the analgesic solution and the syringe must be sterilised by boiling or by autoclaving, chemical sterilisation is unsafe, especially for the syringe and needles The adrenaline must be taken from a sterile ampoule, and not from a rubber-capped phial

OPERATION FOR THE VARICOSE LONG SAPHENOUS VEIN

TECHNIQUE OF LOCAL ANALGESIA

(*a*) *The incision at the groin*—The incisions are marked out accurately (*see* later), and a considerable area around them is infiltrated generously (Fig 164), the skin being raised in pig-skin wheals, then the subcutaneous tissue a little deeper is injected, and last a layer close to the deep fascia is also infiltrated freely Cutaneous sensation is lost in five minutes

(*b*) *For stripping of the internal saphenous trunk*—For "stripping" of the internal saphenous trunk (and ankle communicating vein ligation) the femoral nerve must be injected in order to desensitise the antero-internal aspect of the limb from the groin to the ankle This large nerve trunk lies immediately to the outer side of the femoral artery, underneath

the deep fascia (Fig. 164) The pulsation of the artery mid way between the symphysis pubis and the anterior superior iliac spine is located by direct palpation above the fold of the groin, the nerve lying immediately external to this point. The needle is passed vertically downwards here until the resistance of the deep fascia is felt and overcome by further pressure Aspiration is applied to the needle, to ensure that its point is not in the femoral artery and if nothing is withdrawn 20 ml of analgesic is injected to block the nerve, the needle being advanced a little whilst doing so Confirmation of the accuracy of the injection is usually obtained by the patient feeling pain when the nerve is pricked by the needle.

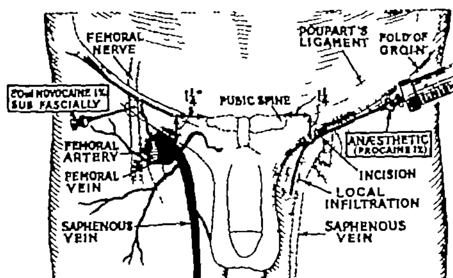


FIG. 164

Local analgesia The infiltration of the groin for the sapheno-femoral ligation. The right side shows the anterior femoral nerve being infiltrated this is necessary for painless stripping.

By the time the sapheno-femoral ligation has been done, the long saphenous vein exposed at the ankle and the stripper threaded into the vein the limb will be anaesthetised sufficiently to permit a painless stripping from the ankle to the groin or vice versa

(c) *Infiltration for the incision at the ankle*—During the pause for the development of anaesthesia in the groin the region about the internal malleolus where the ankle incision will be made is infiltrated superficially and deeply (*see* Fig. 180) *The line of this incision is scratched* on the skin because the swelling made by the local analgesic will have subsided when the time for this part of the operation arrives (*see* Fig. 180 ankle incision) an alternative marker is to leave the hypodermic needle in the skin after the injection

Operative Procedure

POSITION OF THE PATIENT —The whole table is tilted head down to an angle of about 10° This brings the legs just above the heart level This manoeuvre is invaluable for all operations on the veins of the legs, particularly for stripping, as it empties the veins and decongests the whole limb It is equally important not to have the legs too high, otherwise when a large vein is opened air may be sucked into it and the danger of air embolism is present The limbs are abducted to make the groin and inner aspect of the leg more accessible The leg which is being operated on is raised 10° on a padded board (Fig 165)



FIG 165
The limb raised 10° on a board for ligation and stripping of the internal saphenous vein

EXPOSURE OF THE INTERNAL SAPHENOUS VEIN AT THE GROIN —To uncover the internal saphenous vein and its tributaries at the groin with certainty and safety, it is essential to dissect out at least its terminal 3 to 4 inches to the sapheno-femoral junction, and the common femoral vein for a short distance above and below the union By this wide exposure, the frequent variations of the veins and occasionally even those of the femoral artery can be recognised and dealt with appropriately

Landmark of the sapheno-femoral junction —The sapheno-femoral junction is at a point $2\frac{1}{2}$ - $3\frac{1}{2}$ cm (1 - $1\frac{1}{4}$ inches) below and lateral to the pubic tubercle (Fig 166) *All* the incisions have their *centre* at this point, we emphasise the importance of accurately determining this landmark before making the incision

The variable level of the fold of the groin in relation to Poupart's ligament is not generally realised, it depends on the obesity of the patient In the stout the crease is 3 - 5 cm lower than the ligament In thin subjects the skin crease and Poupart's ligament are almost superimposed and an approach here will be found too high for the sapheno-femoral junction We advise that the skin crease be ignored when planning the incision

THE INCISIONS —Two incisions will be discussed the curved or hockey stick," which is preferred and recommended and the oblique

The curved or hockey-stick incision (Fig. 166) —This was evolved from a combination of the oblique and vertical incisions being 8 12 cm long. Its outer half lies in the gutter of the groin and the inner half curves downwards on to the thigh The incision, as its name implies, is shaped like a hockey-stick and lies over the terminal 5 7 cm of the internal saphenous vein It is centred as above

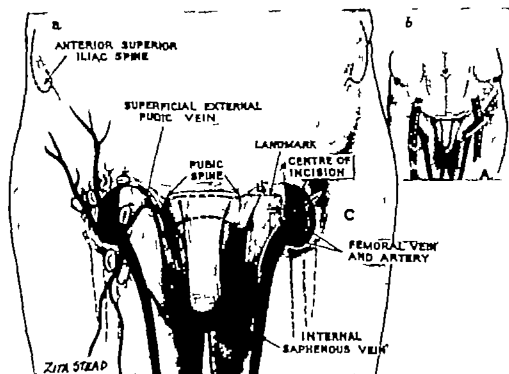


FIG. 166
The incisions for exposure of the termination of the internal saphenous vein

The outer portion of the incision exposes the sapheno-femoral union and the inner part, when strongly retracted downwards will reveal up to 10 12 cm (4 5 inches) of the internal saphenous trunk The incision is especially designed to give access to its postero-internal tributary which often joins it at its upper third

A good scar remains after it (Fig. 167)

The oblique incision (Fig. 166 inset) —This must be centred accurately over the surface marking of the sapheno-femoral junction It is 7 10 cm long and adequate retraction of the wound edges by an assistant is necessary to gain a complete exposure It heals with a fine scar It is parallel to the fold of the groin

The length of the incision —One of us began to ligate the internal saphenous vein with the idea that it should be done through a one-inch



FIG 167
The scars after bilateral ligation of the sapheno-femoral junction



FIG 168
Forcible elevation of the skin edges after making the skin incision

(2 3 cm) incision This was an error with an opening so small it was easy to miss the saphenous vessel entirely to mistake one of its large tributaries for it, to overlook feeding veins, or surprising as it may seem even to ligate the femoral vein A generous incision has avoided such pitfalls "The surgeon should operate by sight, and not by faith (Maingot 1953) for additional *incapacity* follows a wide exposure and the dependable results confirm its suitability Many of the recurrences after operation have resulted from working through an inadequate and wrongly-placed approach

The exposure of the internal saphenous vein—After the incision has been made and the skin cloths applied the centres of the wound edges are grasped by Lane's forceps, and are forcibly elevated and separated (Fig. 168) This

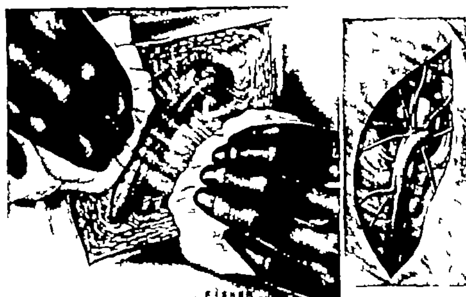


Fig. 169
Location of the internal saphenous vein by stretching of skin and fat. *Inset*—the average finding of the internal saphenous vein

manoeuvre is invaluable it lifts the fat off the vein and its tributaries making them readily visible as the wound is deepened in the line of the skin incision through the two layers of superficial fascia With an accurately placed incision it is usual to uncover the vein as it lies at the foramen ovale and for two to three inches below without a pause or the division of a single blood vessel

In patients with an ulcer or eczema of the leg, there is often adenitis and periadenitis of the vertical and horizontal groups of saphenous lymph nodes these are avoided by retracting them downwards and outwards. This eliminates a possible cause of wound sepsis Distended lymphatic capillaries can occasionally be seen passing into the femoral canal. By siting the incision correctly and deepening it vertically the embarrassing bleeding which follows the division of matted lymphatic nodes is avoided If the glands are unduly

enlarged, one should be removed and sectioned; in this way one patient with an ulcer of the ankle was found to have lymphatic leukaemia

Locating the internal saphenous vein —Occasionally, on dividing the two layers of superficial fascia, especially if the incision is incorrectly placed, the long saphenous vein is not apparent, but fascia covering the pectineus muscle



Fig 170
The Travers' self-retaining retractor

may be exposed instead By inserting two swabs into the depths of the wound (Fig. 169) and pressing its fatty sides gently and steadily apart, the saphena magna will be seen through the fat as it is retracted If this fails, an alternative guide to it is that of tracing deeply any presenting vein (almost invariably present in the wound) This leads to a larger tributary and thence to the long saphenous vein Superficial veins encountered whilst making the incision are better not divided until the internal saphenous vein is located

A self-retaining retractor is inserted into the wound, Travers' is a suitable pattern (marked X on Fig 162 and also *see* Fig 170)

The technique of dissection of the vein (Fig. 171) —The dissection of the internal saphenous vein caused one of us difficulty until two principles were grasped First, that the vein strips best on its nude shiny wall and not outside the thin layer of adventitious fascia that ensheathes it and also obscures its tributaries. A rapid, clean dissection is possible by using Mayo's straight round-pointed scissors Secondly it is undesirable and unnecessary to grasp any vein wall with the dissecting forceps because varicosities are unpredictably and disconcertingly friable and bleed copiously if torn

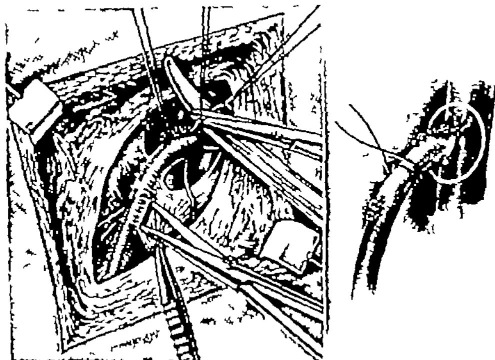


FIG. 171
The technique of the dissection of the internal saphenous vein and the ligation and division of the tributaries.

The fascia immediately outside the vein wall is held by the dissecting forceps, and the space between it and the vein is systematically displayed by gently opening the points of the scissors between them parallel to the vessel (Fig. 171) It is quick and effective and small tributaries are seen readily The saphena magna and its radicles are dissected steadily until the faint white line indicating the union with the femoral vein is seen just inside the foramen ovale The dissection includes opening the femoral sheath which has a thin continuation on to the internal saphenous vein. The femoral vein is exposed for ½ 1 cm above and below the foramen ovale and for at least two-thirds of its circumference. The sapheno-femoral union and the terminal half centimetre of internal saphenous vein are closely invested by the femoral sheath and as already mentioned this is snicked by the scissors and reflected upwards and outwards in the dissection of the terminal long saphenous and femoral vein

Two observations during this procedure are of interest:

(*a*) the enlarged varicose vein contracts down to normal proportions as a result of the dissection necessary to display it, and

(*b*) on watching some gross varicose veins, their distension and collapse synchronous with respiration and the heart beat are apparent

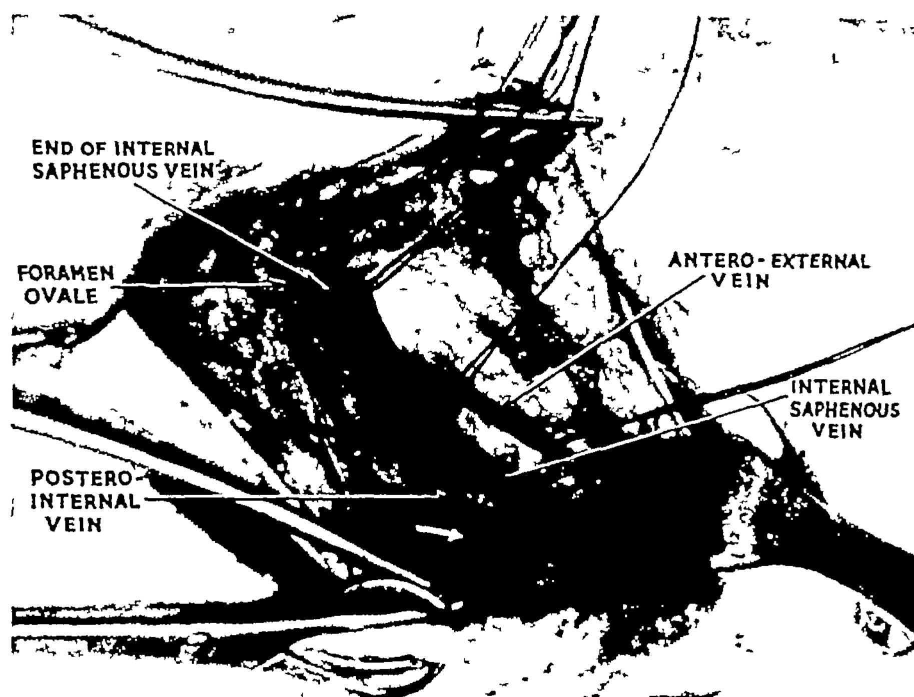


FIG 172

Ligation of internal saphenous vein and its tributaries

The postero-internal and antero-external tributaries are joining the internal saphenous vein lower than usual and the wound is being forcibly retracted downwards especially to expose the former Note large postero-internal vein also that the vessels have been identified and ligated twice before division

THE TRIBUTARIES OF THE INTERNAL SAPHENOUS VEIN (*see* Figs. 177A, 177B and 172) —There are six significant veins joining the terminal 1 to 15 cm of the internal saphenous vein It is seldom that one is absent, although they present in bizarre combinations (*see* Chapter III) All but the postero-internal vein lie in the superficial layer of superficial fascia, the latter is on the deep fascia. They are as follows :—

1 *The superficial circumflex iliac vein,* entering from above and laterally

2 *The superficial epigastric vein,* passing vertically downwards from the fat of the lower abdominal wall (Fig 174)

3 *The superficial external pudendal vein,* passing slightly downwards and outwards from the mid-line (external genitalia and perineum).

These three vessels usually join the last centimetre of the internal saphenous vein



FIG. 173
The dissection, double ligation and division of a tributary of the internal saphenous vein.

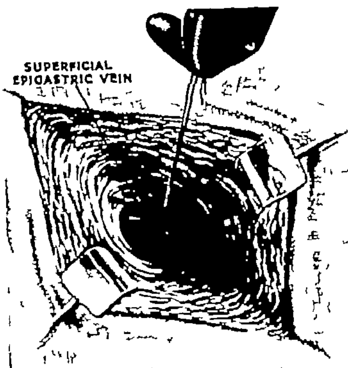


FIG. 174
Showing how the superficial epigastric vein is easily missed. In consequence the long saphenous vein is ligated distal to it and recurrence of the varices is assured in one to five years, the venous hypertension being carried through this undivided tributary

4. *The postero-internal (accessory saphenous) vein* runs upwards on the deep fascia from the postero-internal aspect of the thigh to join the inner aspect of the internal saphenous vein This vessel is always sought and divided, because it may be the channel of discharge of the external saphenous vein which might have been made inefficient by the internal saphenous

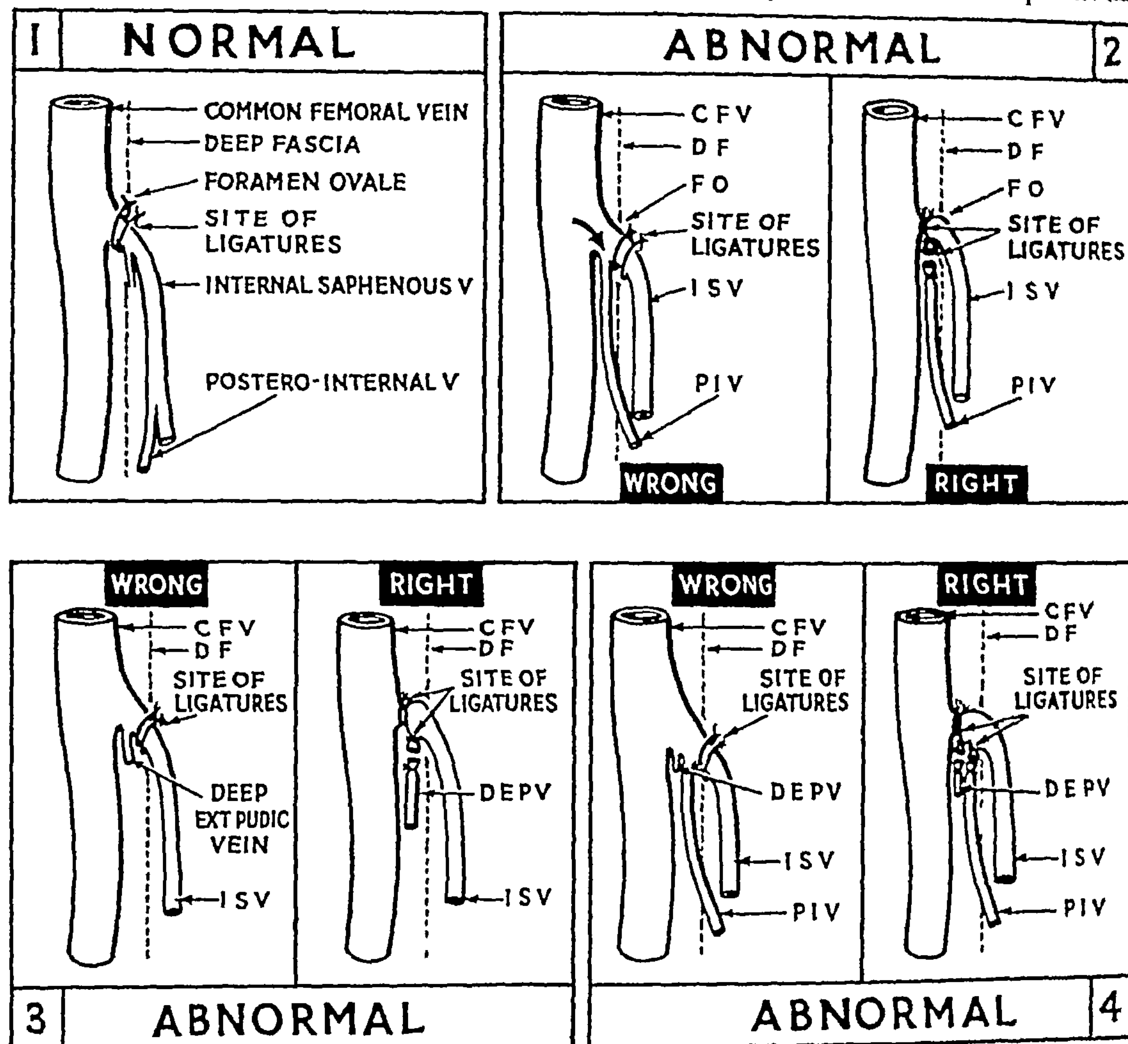


Fig 175

Variations of the postero-internal and deep external pudic veins as they join the termination of the internal saphenous vein *inside* the foramen ovale The right and wrong ways of placing the ligatures are indicated The " tie " must be flush on the femoral vein

incompetence through this connection Normally the postero-internal vein runs into the last 1 - 15 cm of the internal saphenous vein, and is readily dealt with When it is not apparent, it is searched for in three places (*a*) about 17 - 20 cm from the sapheno-femoral junction—this is easily available through the hockey-stick incision on strong retraction downwards of the wound, for the fat and skin here are mobile (Fig 172); (*b*) at the sapheno-femoral junction *inside* the foramen ovale where it may be beside or joined by the deep external pudic vein (Fig 175, 2 and 4) The illustration indicates how the ligatures must

be placed (c) when (a) and (b) yield negative results the femoral vein is exposed downwards from the foramen ovale and the vessel may be found joining the parent trunk directly having pierced the deep fascia early This is admittedly a rare variation The lower margin of the foramen ovale usually contains the superficial external pudic artery which requires division first.

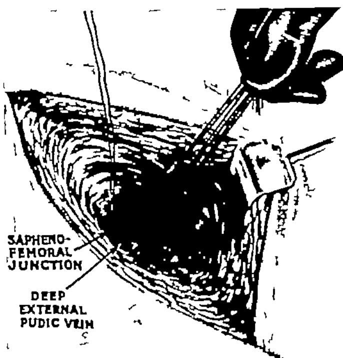


FIG. 176
The deep external pudic vein joining the internal saphenous vein at its termination inside the foramen ovale It is easily overlooked

The antero-external tributary or *external superficial femoral vein* runs subcuticularly diagonally across the thigh upwards and inwards from the antero-external aspect of the leg and knee, and joins the outer side of the last inch (2 5 cm) of the long saphenous vein This vessel (when varicose) is visible through the skin and is often erroneously referred to as the internal saphenous vein It may join 10 cm from the sapheno-femoral union, it is occasionally large and straight and is mistakable for the internal saphenous vein

The deep external pudic vein (Figs. 175 and 176)—In 30 to 40 per cent. of cases this vein is present and joins the saphena magna obscurely on its postero-internal aspect precisely at its termination (*inside*) of the foramen ovale. It is to expose this that two-thirds of the circumference of the femoral vein are cleared especially on its inner side and gentle traction outwards is made on the internal saphenous vein Not infrequently it is joined by the postero-internal vein (accessory saphenous vein) (Fig 175 (4))

Discussion —There may be five to ten venous tributaries joining the last 6 - 7 cm of the internal saphenous vein, consisting of the duplication, or occasionally triplication, of the vessels just detailed. In addition there are often lesser unnamed veins, including one from the lymph nodes

The tributaries vary greatly in their pattern of union, it is unusual to find the same combination twice In twelve consecutive cases they were all

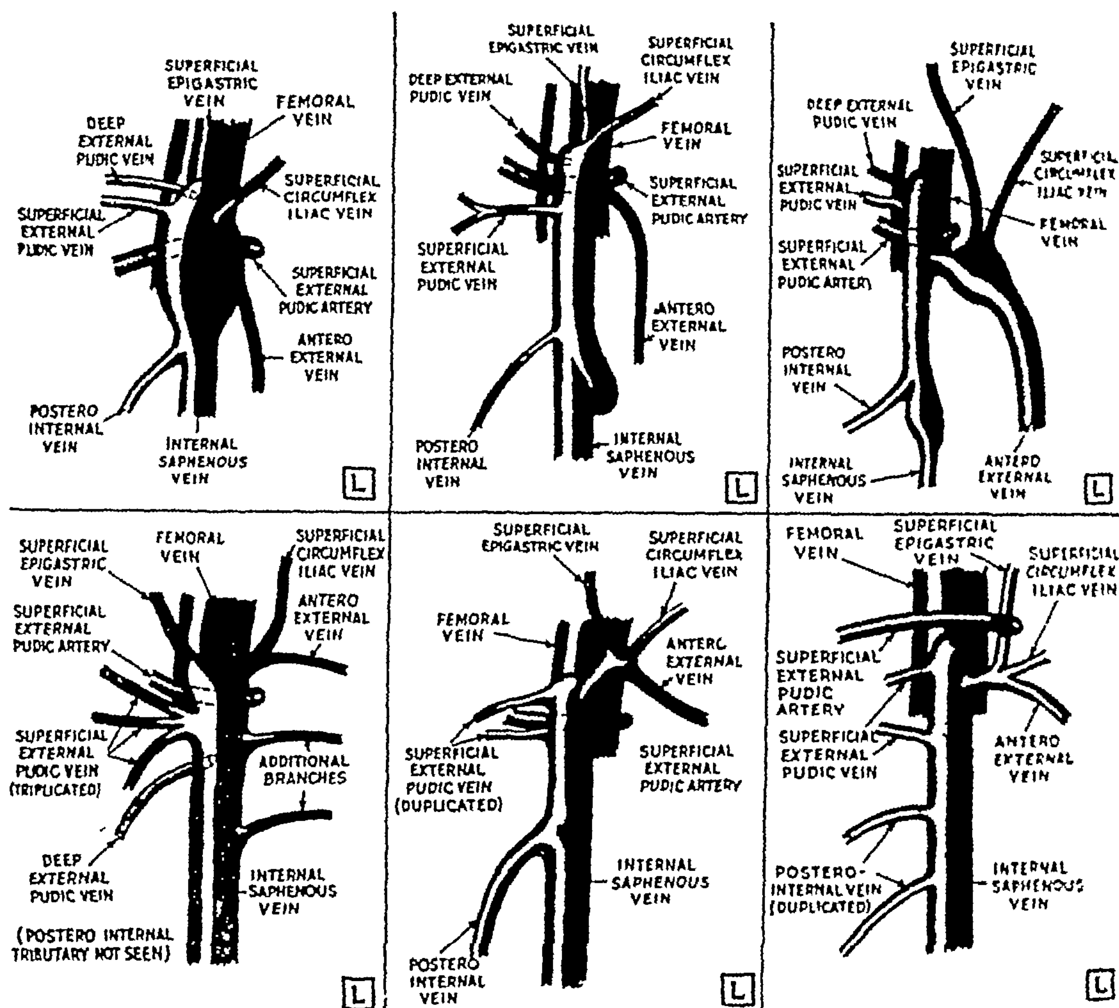


Fig 177A
See legend on p 211

different, although several of the operations were for bilateral varicose internal saphenous veins (Fig 177); to facilitate comparison they are made left sided).

The radicles may join in twos or threes or occasionally the superficial external pudic, superficial epigastric, superficial circumflex iliac and antero-external veins combine to form a large short common trunk of entry almost at the sapheno-femoral union

We repeat that a full exposure of the femoral vein for at least half a centimetre above and below the sapheno-femoral junction is essential, as a superficial vein occasionally joins the parent vessel between these points

Much of the permanent success of the operation depends on the ligation and division of every tributary because if one remains connected with the femoral vein and if the femoral or external iliac valve is incompetent the high intravenous pressures would still be transferred to this subcutaneous vein and would keep the venous dilatation active even after stripping of the saphenous trunk From such an undivided vein over a period of years a plexiform

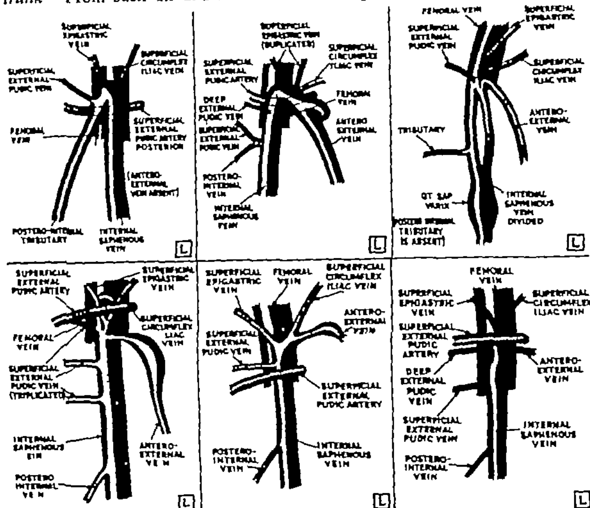


FIG. 177B

Twelve consecutive dissections of the termination of the long saphenous vein. They are different although some are bilateral veins (the right have been transposed to the left to facilitate comparison)

mass of thin-walled subcutaneous varices develops, ultimately connecting it with the saphenous trunk (if present) and its tributaries below

Unless all the subordinate vessels of the internal saphena are tied and cut it is usually impossible to do a flush sapheno-femoral ligation

In spite of being alert it is surprisingly easy to overlook the superficial epigastric and circumflex iliac veins One of us recalls demonstrating the procedure for the varicose internal saphenous vein to some visiting surgeons and on completing it was asked to recapitulate the steps, naming the ligated

vessels During it the undivided superior epigastric vein was revealed: it had remained concealed by the superficial external pudic artery passing over it in the upper edge of the wound (Fig 178)

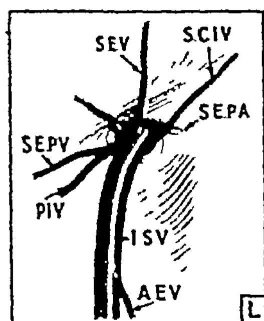


FIG 178
The superficial epigastric vein concealed by the superficial external pudic artery which is also abnormal in this patient for it is emerging on the inner side of the internal saphenous vein instead of the usual outer side

The superficial external pudic artery (Fig 23, Chap 3, and Fig 178) This vessel runs medially in various relationships to the end of the internal saphenous vein Generally it runs underneath it in the lower edge of the foramen ovale but it may pass over the long saphenous vein (25 per cent of cases) and requires section, for in this superficial position it conceals the superficial epigastric vein and the sapheno-femoral union Less often it divides and both branches pass either superficial or deep to the saphenous vein, or one may pass over and the other under it on the deep fascia They are divided as necessary, no attempt is made to preserve them

Ligation of tributaries—(*a*) When all the tributaries are defined, they are divided between ligatures The outer ligatures are cut short but those on the internal saphenous vein are held long, for traction on them elevates it to the surface and facilitates the operation (Fig 176)

(*b*) *The deep external pudic vein*—This vein when present is divided, but it is an excellent step to tie the sapheno-femoral junction first It ensures that this key tie really is above all the tributaries and is flush on the femoral vein (Fig 176) Further, it avoids leaving the ligated stump of a small thin-walled vessel subject to the high thoraco-abdominal pressures which may reach 200 mm of mercury during vomiting and coughing, a tie which could yield under such strain (*see also* Fig 175)

Ligation of the internal saphenous vein—The end of the long saphenous vein is ligated with stout black No 50 linen thread This material bites into the vessel wall and ties with a non-slipping knot Catgut ligatures on the proximal end of the saphena magna have yielded, occasionally with fatal or critical haemorrhage To make the saphenous stump safe, a second ligature is applied to it, or better still, it is transfixed with fine No 90 thread, and tied as is a hernial sac (Fig 179) The great surgical master, Halsted (1893), showed that transfixion is the certain way to secure an important vessel, and that an encircling ligature can be "shot off" like a pea from a pea-shooter As the pressures exerted on the stump of an incompetent internal saphenous vein may equal or exceed those in an artery, the need for security is obvious

Inspection of the common femoral vein—Before tying the end of the saphenous vein, the femoral vein is inspected for a short distance above and below the junction It is essential to see it as well as the long saphenous

vein for the former can be mistaken for the latter and erroneously tied, especially in very thin patients

An alternative method of sapheno-femoral ligation.—Another method of ligating the internal saphenous vein at the groin is mentioned to condemn it. It is used freely but it is not 100 per cent. safe. It consists in exposing the internal saphenous trunk and dividing it between haemostats 4 6 cm below the sapheno-femoral junction. The upper forceps is used to elevate the vein The tributaries are easily defined, and divided, until the sapheno-femoral union is displayed at which point it is clipped and firmly tied.

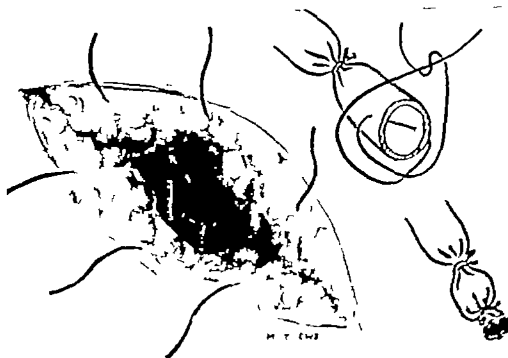


FIG. 179
Ligation and transfixion of the stump of the internal (or external) saphen[illegible] also the closure of the dead space by interrupted ligatures.

This technique is inadvisable, because of (1) the unpredi[illegible] of varicose veins and the possibility of tearing the fragile vari[illegible] vessel off the side of the femoral vein and (2) the possibility of [illegible] the femoral vein or artery for the long saphenous vein at the b[illegible] of the operation—a perilous but feasible possibility especially in the [illegible]. In 1951 one of us after twenty-five years of varicose vein surgery [illegible] 3-4 cm. of the femoral artery in an emaciated patient under the [illegible] that it was the internal saphenous vein. The error was realised by [illegible]ce of tributaries, then the pulsation was noticed and the necessary [illegible]ation followed. This incident served to show how serious the pr[illegible] of the vessel would have been It occurred when operating [illegible] excellent

assistant and good conditions in every way (3) Last, in the effort to make a flush ligation, the femoral vein could be drawn up somewhat into a V, clipped widely and, on tying, narrowed or occluded, which might lead to thrombosis

It may be said that these are theoretical objections but our experience is that every error can occur in spite of care and we suspect that others find it so "The more care we take, the fewer mistakes we shall make" (Milligan 1954)

Saphenectomy by stripping.—When all the internal saphenous tributaries are divided, and the sapheno-femoral junction has been doubly tied a thread is passed twice round the saphenous vein 1½ - 2 inches (3½ - 5 cm) below the sapheno-femoral point It is not tied but its ends are held by a heavy haemostat Its purpose is to prevent a backflow of blood from the vein when it is opened (Fig 171) All is ready for extirpation of the trunk of the internal saphenous vein by stripping it out

A swab is placed in the wound, the self-retaining retractor is eased, and the vein trunk is now exposed at the ankle

Exposure of the internal saphenous vein at the ankle—The purpose of division of the internal saphenous vein at the ankle is to complete the elimination of the saphenous trunk from the groin to the ankle Before adopting this groin to ankle ablation (pre-1940), when the operation was limited to the thigh, considerable varices reappeared in the leg within three years Since the ankle extension, the results have greatly improved. Myers and Cooley (1954) continue the ablation into the foot; we have not found this necessary

Surgical anatomy—The internal saphenous vein at the ankle is in the groove between the anterior border of the internal malleolus, and the tendon of tibialis anticus The vessel lies deeply on the bone, immediately under the slight deep layer of subcutaneous tissue, it is straight, pale blue, and thick-walled and should not be confused with a large, tortuous soft purplish vein which in the varicose leg is often present here superficially The trainee surgeon will find it useful to mark out the vein at the ankle while the patient is standing, before the operation, because occasionally the exposure is difficult The saphenous nerve, which is quite small, lies intimately by the vein, usually anteriorly, and is avoided by clean dissection; patients complain of the pain or impaired sensation of the lower leg, inner foot and hallux that follows its injury This vein exposure is also invaluable for "cut-down" infusions when other superficial veins have been used

The incision—The incision is about one inch (2 5 cm) long in the creases of the skin which here run transversely and at right angles to the line of the vein (Fig. 180) Its centre is the anterior border of the internal malleolus at the upper end of the groove. An almost invisible scar follows

A longitudinal incision also gives a good exposure and is preferred by some

Location of the vein—The skin edges are grasped with tissue forceps and strongly elevated. The rounded points of the scissors are thrust forcibly through the fat until they impinge on the bone and then they are opened

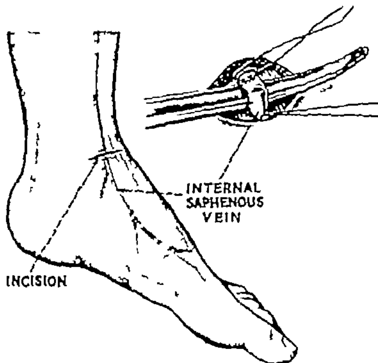


FIG. 180
Ligating the internal saphenous at the ankle. The incision is outlined. The inset shows the vein ligated inferiorly a guard ligature round it superiorly and vein incised ready for the insertion of the stripper

firmly In the bottom of the resulting small cavity the vein is usually visible under the deeper layer of superficial fascia, which is snicked with the scalpel Observance of the landmarks and penetration of the superficial fascia is essential for a prompt exposure otherwise a time-consuming dissection in the fat can follow and an unnecessary extension of the wound In the slender ankle the vessel can be seen through the skin and the incision is made immediately over it. In the fat-covered or scarred ankle little difficulty will be experienced if the above points are observed.

The distal part of the vein is tied with fine catgut, which is used here instead of thread because unabsorbable ligatures in this area tend to be cast out through pustules. A double hitch ligature is passed round the vein superiorly and its ends are held untied with artery forceps (Fig. 180) The vessel elevated to the skin level by traction on the lower tie is then incised with a scalpel obliquely between the ligatures, raising a little flap.

The procedure of stripping now follows

TECHNIQUE OF STRIPPING

The instrument for internal stripping of the trunks of the varicose saphenous veins is Myers' flexible stripper (modified). This is a flexible wire about a yard long. At its leading end is a small round knob (available in three sizes) and at the other extremity is a concave steel shoulder about 1 cm in diameter on which the vein will be telescoped (Fig 181, *see also* Figs 157 and 158). This is the stripping instrument of choice and we use it to strip veins from the ankle upwards or from the groin downwards

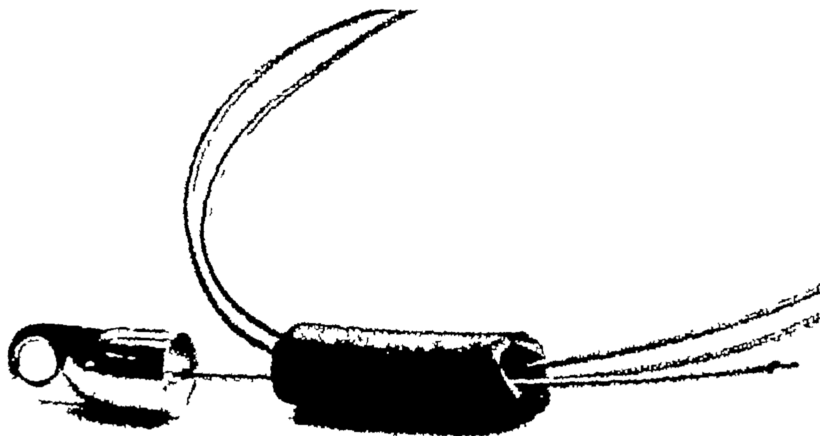


FIG 181
Modified Myers' stripper

The stripper passes more easily from the ankle to the groin, riding readily over valve cusps, but it can be done in the reverse direction

Technique of stripping of the internal saphenous vein—The long saphenous vein at the ankle has been isolated, ligated and cut half across above the lower ligature. The tip (Fig 182) of the flexible stripper is inserted into its lumen and threaded up as far as possible; it frequently runs uninterruptedly until it appears in the vein at the groin, which vessel is divided below the sapheno-femoral ligatures and the stripper tip is drawn out of the vessel to the surface until the stripping shoulder is all but in contact with the ankle wound (Fig. 183) A ligature is tied round the vein and the stripper at the ankle, this prevents the stripper being pulled right through a very large vein without removing it

The vein at the ankle is divided distal to the point of entry of the stripper

The act of stripping—The lips of the skin incision at the ankle are widely retracted and undermined and the vein is freed for 1-2 cm; this makes a space into which the large shoulder of the instrument can pass without touching the skin and avoids an infection into the long vein bed It also ensures that the stripper is inserted into the correct tissue plane for stripping (Fig 184). Traction on the stripper at the groin draws the stripping shoulder into the



FIG. 182
Myers stripper about to be introduced into the internal saphenous vein at the ankle.



FIG. 183
Stripping the internal saphenous vein from the ankle. The stripper has been passed and brought out from the wound at the groin.

opened ankle wound The stripper is grasped with both hands and a steady vibratory pull is applied to it The instrument will disappear from the point of entry, and a growing bulge of the vein telescoping on the shoulder is visible



FIG 184

The act of stripping The stripping shoulder has passed into the wound at the ankle The wound here and at the knee has been closed the stripper is about to be drawn from the ankle to the groin The method of "clean" stripping is being used

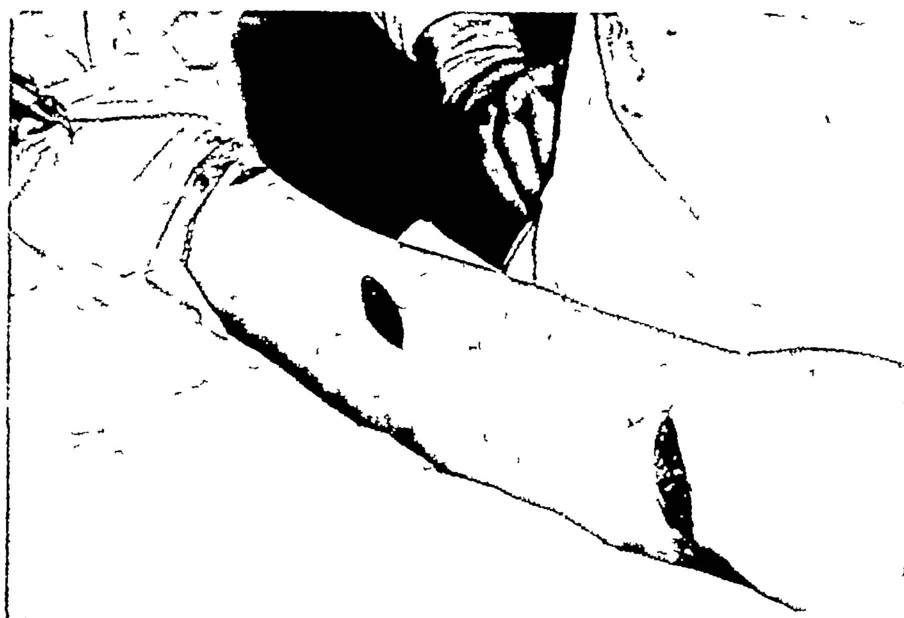


FIG 185

Stripping the internal saphenous vein, subsidiary incisions have been needed

under the skin as it proceeds up the leg and thigh towards the wound of exit The stripper is often held up temporarily at points where tributaries join it, especially below the knee, where three large veins enter, but the oscillatory traction is sustained, the puckered skin over the protruding vein on the stripper is pressed away from it and snaps are felt as tributaries yield; finally, the

vessel appears in the wound as a fusiform "blob" telescoped on the instrument (see Fig. 157)

The traction is sustained and continuous in order to stretch the tributaries before they break off this assists haemostasis by their elastic recoil The stripper must be kept straight as it is gripped it must not be sharply bent or hitched round the hand or fingers for this will make permanent kinks in it



FIG. 186
The extending needle stripper in the internal saphenous vein, introduced at the groin preparatory to stripping from above downwards.
Note—The sapheno-femoral junction is ligated twice the internal saphenous vein has been divided. A ligature has been tied round the vein and the stripper

and will make the instrument "varicose" and compromise future operations. The pull required is very often considerable indeed the assistant's help to push the stripping shoulder digitally through the skin is occasionally required The traction however should always be controlled, never violent.

Interrupted stripping—Sometimes the tip of the stripper impacts before the sapheno-femoral junction is reached, but often it can be freed and passed further by manipulating the point of the hold-up with the fingers through the skin and at the same time rotating, withdrawing and advancing the stripper combined with moving the limb Should the stripper impact

immovably before it reaches the groin its tip is cut down upon and by direct manipulation it may pass onwards If not it is brought out of the vein to the surface and the vessel from the ankle to this point is stripped as described for the whole vein The stripper is cleared of the venous fragment and is re-introduced into the vein (if possible for it may be too small or tortuous) and threaded upwards until it impacts or until the entire vessel to the groin is threaded on to it (*see* Figs 183 and 185)

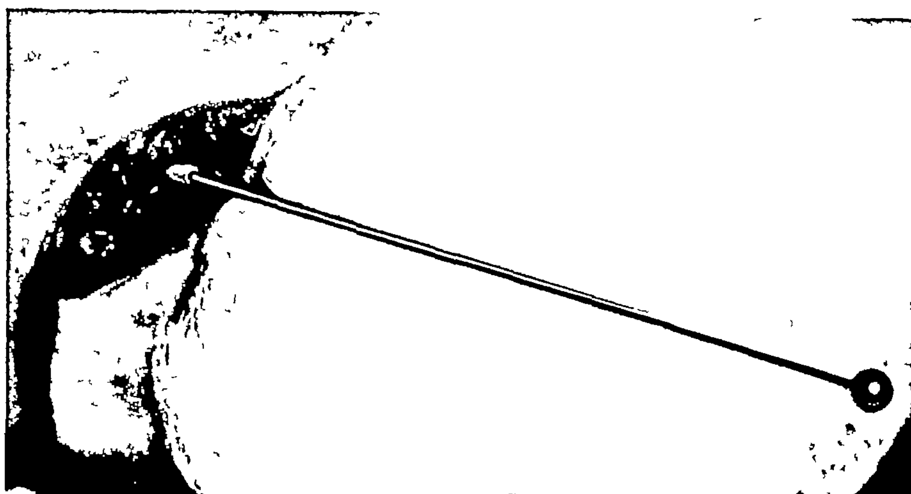


FIG 187
The ball tip of the extending needle stripper protruding from an incision in the leg

The saphenous trunk may require to be exposed once, twice or thrice The more varicose, sinuous and pouched it is, the oftener will the stripper be held up and have to be cut down upon, extracted and re-inserted Occasionally it cannot be introduced again because the vein is too narrow and fibrosed In this event the stripper is introduced from the groin (Figs 186 and 187) It frequently succeeds when the upward route fails, although the tip is prone to lodge in valve cusps and dilatations or to wander into the large tributaries at the knee, especially into the posterior arch vein

By perseverance and ingenuity the whole of the saphenous trunk can be removed

To determine the whereabouts of the tip of the stripper —Occasionally, when stripping a saphenous vein in an obese limb, the tip of the stripper becomes impacted before it reaches the sapheno-femoral or sapheno-popliteal junction and it is not possible to determine its exact whereabouts by palpation This can be arrived at by taking a similar stripper and laying it exactly alongside the first The tip of the second stripper will then be over the tip of that in the vein This simple step is invaluable

Division of the saphenous trunk before stripping.—Before a vein is stripped it must be divided at both ends, *i e* at the point of the introduction

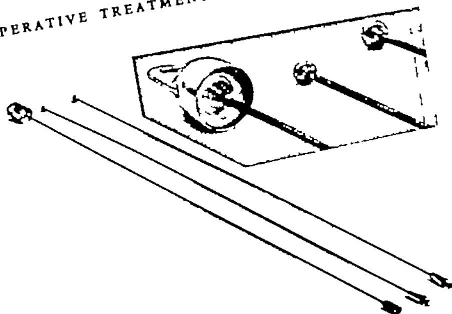


FIG. 188
Semi-stiff extending stripper

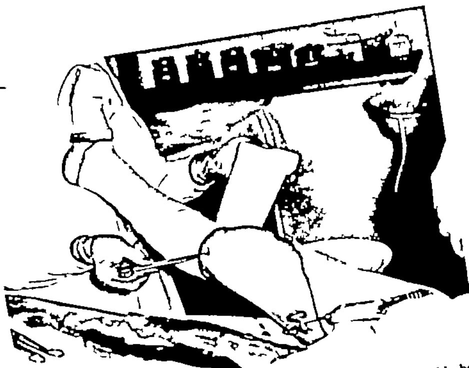


FIG. 189
Clean stripping of the internal saphenous vein. The wound at the ankle has been sutured and dressed. As the stripper is drawn from the ankle the limb is firmly bandaged with a sterile crepe bandage. The haemostat tip is indicating the position of the stripping shoulder (The staining on the towel is not blood but iodine.)

of the stripper, at the groin or the ankle and also beyond the place of its emergence This is so obvious but it is easy to forget, and if it is omitted the vessel will refuse to strip, or it will be torn out from the foot, or. if the stripping is from above—downwards, from the sapheno-femoral union, which would be a dire error.

A " clean " method of stripping varicose veins (Fig 189).—After stripping the trunk of an internal or external saphenous vein, the gush of blood from the wounds is usually small but occasionally is considerable Tilting the patient into the Trendelenburg position and pressing a rolled towel on the vein bed will often control it On one occasion, however, the blood loss necessitated a blood transfusion. This blood loss is undesirable and a way to avoid it was found

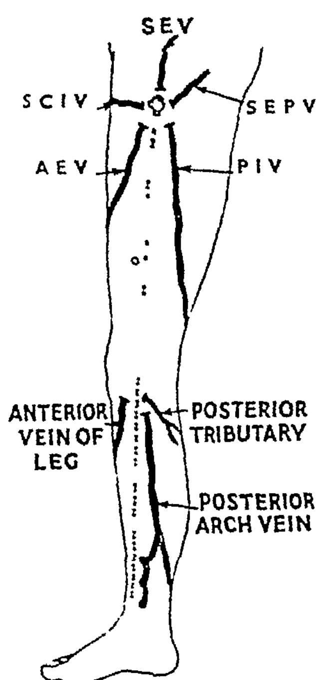


FIG 190
The internal saphenous vein and its tributaries after efficient stripping Note that these tributaries are interconnected and will fill up again if one is linked with a source of venous hypertension, *e g* at the sapheno-femoral junction

The following " clean" technique was devised It is particularly applicable when the stripper has run unobstructed from the ankle to the groin or to the popliteal space, although it can still be used when several incisions are needed It aims to bandage the limb synchronously with the stripping of the vein

The stripper is pulled out of the wound of exit until its other end disappears for 1 - 2 inches (5 - 7 cm) into the incision of its introduction (usually at the ankle) This incision is then stitched and dressed The fat and skin of the groin wound are all but closed, leaving a gap for the emergence of the telescoped vein on the stripping shoulder The firm bandaging of the limb with a sterile crêpe bandage by the assistant begins at the ankle as the surgeon starts stripping. As it proceeds the bandaging follows closely behind the stripping shoulder (*see* Fig 189) The instant pressure minimises or eliminates bleeding, obliterates the vein bed, and a bulky clot cannot form in it Post-operative swelling, bruising haematoma and discomfort are minimal

When several incisions have been necessary, they are sutured and bandaged immediately after the stripping, section by section, the bandage being prevented from unwinding by clipping it with a haemostat Controlling the bleeding makes the operation a more attractive procedure

The state of the internal saphenous vein drainage area after stripping is shown on Figure 190.

External stripping—with Mayo's ring stripper (Fig. 160) —Occasionally a varicose internal or external saphenous vein will be encountered in which

the flexible internal stripper even with the smallest tip becomes impacted when attempts are made to pass it When the hold-up is exposed the saphenous trunk is usually found to be narrowed white fibrosed and unyielding to the tip of the stripper perhaps from sclerosing injections previous phlebitis or scar tissue from ulceration or previous operation.

If an attempt to pass the stripper from the other end of the vein fails to reach the obstruction resort can be made to Mayo s ring stripper to remove the resistant portion It can be used either up or down the limb

The saphenous trunk is divided and mobilised in the wound Its end is threaded into the ring of the stripper and held by a haemostat The stripper is pushed cautiously to and fro subcutaneously along the trunk of the vein It frequently proceeds rapidly and easily but sometimes it is held up by a tributary insistent quick jabs or moving the puckered skin over the ring often free it, and the blind dissection proceeds. The artery forceps holding the end of the vessel is steadied in the wound and occasionally allowed to run slack but it is not pulled on lest the vein break, as it does occasionally in spite of care. When the instrument has been inserted to the full or is held up firmly the ring, which is easily palpable through the skin is cut down upon and brought to the surface The vessel is divided here and the portion freed is drawn out of the wound The stripper is withdrawn from the first incision and is re-threaded on to the vessel at the second point after resistant tributaries have been divided or a communicating vein tied (Fig. 160) Thence the stripping continues until the saphenous trunk or large tributary is removed.

Rupture of the vein during ring stripping—During the ring " stripping the vein may break without warning, but the stripper is kept in place, its tip indicates the site of the rupture, and a longitudinal incision is made over it. The vein is identified and the obstruction is divided the stripper is re-inserted and the process continues.

The likelihood of the vessel breaking is reduced by twisting it repeatedly with the haemostat.

OPERATION FOR THE VARICOSE SHORT SAPHENOUS VEIN

The surgical anatomy—The short saphenous vein beginning between the outer margin of the tendo-Achillis and the external malleolus, courses straight up the middle of the calf to the centre of the popliteal space In its lower third it lies on the deep fascia but at the musculo-tendinous junction of the gastrocnemius it enters a fascial compartment in the muscle aponeurosis which leads it into the lower part of the popliteal space Behind the knee are two longitudinal skin grooves and the vein lies midway between them For its variations see Chapter III but we must add that in our experience of the varicose external saphenous vein these variations are relatively rare the union with the popliteal vein in the popliteal space being usual varying in level from below the knee joint to the adductor foramen in the lower third of the thigh

Position of the patient.—The patient lies prone, the head of the table is tilted down 10°, the foot rests on a pillow which flexes the knee a little, slackens the skin and the fascia and facilitates the exposure (Fig 191) The limb is fully draped with sterile towels (Fig 196)

Local analgesia for external saphenous "stripping" (Fig 191) —The areas of the proposed incisions at the popliteal space and outer ankle are desensitised by direct infiltration of the skin, subcutaneous tissue and beneath the deep fascia The tract of the external saphenous trunk is rendered analgesic by direct injection of the medial and lateral popliteal nerves at the upper part of the popliteal space as they are exposed in the sapheno-popliteal ligation These nerves are comparatively superficial in the popliteal space

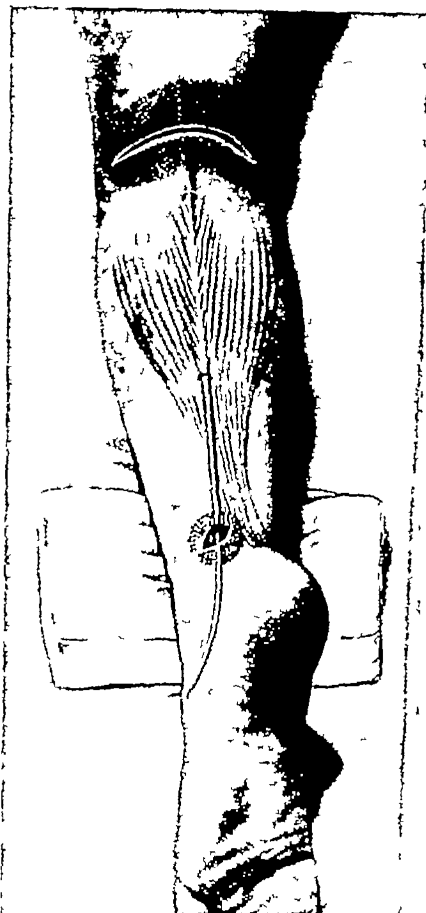


FIG 191
Depicting the infiltration with analgesic for operation on the external saphenous vein

The ankle-knee approach.—When there is no ulceration or eczema at the lower leg, the operation on the varicose external saphenous vein is begun at the ankle and finishes at the knee. This plan was dictated by the variability of the termination of the external saphenous vein By starting below, knowledge of the whereabouts of the sapheno-popliteal junction becomes available, as will be shown shortly.

The vessel is exposed as it lies outside the tendo-Achillis, 4 - 5 cm above the tip of the external malleolus (Fig 191) The incision, one inch (2 5 cm) long, is transverse in the normal skin folds It begins at the outer border of the tendo-Achillis and passes forwards It is deepened through the fat until the edge of the tendon is just visible The wound lips are forcibly elevated as in the other vein exposures The blades of the scissors are thrust firmly through the fat and opened widely along the line of the vein, when it will be seen immediately outside the tendon, under the second filmy layer of superficial fascia, it is a large, straight vein The sural nerve, which is of considerable size, is visible on the antero-external aspect, closely applied to it, and is avoided This close vein-nerve association (Fig 192) may in part explain the severe pain that occurs with phlebitis in the short saphena, whether inflammatory or chemical

The vessel is cleared for 2 - 3 cm, its lower end is tied with catgut, and a double loop is passed around it proximally, and the ends are held long The

vein is half cut across between the ligatures and the stripper is passed upwards into it.

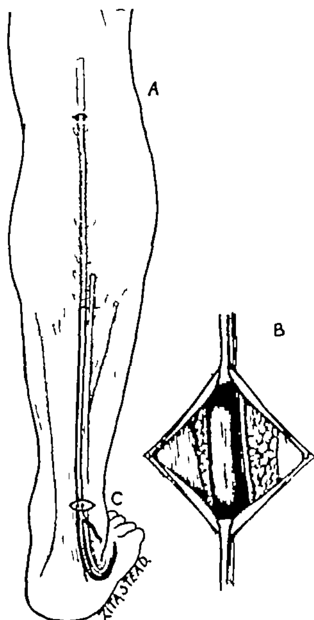


FIG. 192
The nerve-vein relationship at the ankle i.e. the external saphenous vein and sural nerve.

Alternative ankle incision for the short saphenous vein—When there is a large " bog " of dilated veins behind and below the external malleolus as is usual in severe cases of short saphenous incompetence, it is advisable to do a formal dissection and removal of as many of these as possible. This is

done by a longitudinal curved incision running half an inch behind and parallel to the fibula and external malleolus The dissection and removal of this venous cluster, consisting of many dilated tributaries of the short saphenous vein in this region, has considerably improved the result in these severe cases

To ensure sound healing and a good scar this longitudinal wound needs care and accurate pressure bandaging for four to six weeks in the post-operative period.

Passing the stripper —The stripper is introduced gently towards the knee It may run easily until it impacts at the sapheno-popliteal junction, by a slow sensitive insertion, "jumping" the stripper into the popliteal vein will be avoided Sometimes it impacts at the mid or upper leg where the vessel may end prematurely in the veins of the calf The instrument occasionally rides on considerably above the knee, suggesting that it has passed into the popliteal vein, or that this external saphenous vein is one of those which passes to the upper reaches of the long saphenous vein, or of the variety which bifurcates in the popliteal space and one part continues upwards into the hamstrings The stripper can usually be palpated in these positions, or be seen puckering the skin when it is moved The operation is planned to deal with these eventualities

The stripper may impact at the musculo-tendinous junction of the gastrocnemius where the vein passes into the aponeurotic compartment in the deep fascia at the mid-calf Other points are the connection with a perforating vein at the outer lower third of the leg and the entrance of tributaries; a varix or saccular dilatation sometimes hitches the stripper Rarely when the short saphenous vein joins the internal saphenous vein below the knee, the stripper passes inwards into the latter vessel

The point of impaction is cut down upon, as required It may be possible to further the stripper by direct manipulation, twisting, turning and moving it to and fro If not, the vein is opened and the intervening section between this and the initial incision is stripped out The stripper is re-inserted and where it lodges it is again cut down upon until ultimately the termination of the external saphenous vein is located

The vessel's extirpation may lead to an undiagnosed varicose internal saphenous vein that will require similar eliminative therapy, because if the short saphenous vein is defective, and joins it, probably both are incompetent An exposure may be required in the middle or upper third of the thigh

Actually, so tedious a procedure as sketched is unusual and the stripper usually runs uneventfully to the sapheno-popliteal junction

The incisions for sapheno-popliteal vein ligation.—Three incisions are available for this operation—the transverse, the curved, and a longitudinal extension of these

A longitudinal incision in the mid line behind the knee must be avoided. It gives sure access to the sapheno-popliteal junction but it heals with a wide, unsightly scar that may become keloid (Fig. 193) sensitive, weak or eczematous so we cannot advise it.

The curved or transverse approaches are satisfactory when the site of the termination of the external saphenous vein is known precisely as by pre-operative palpation a venogram or threading the stripper along it

The curved incision (Fig 191) —This resembles an inverted goitre incision For the average varicose external saphenous vein it begins half an inch above the level of the transverse crease behind the knee it curves upwards about an inch, passing from one longitudinal groove to another The skin flap with the subcutaneous fat, is reflected downwards thus exposing a circular area of deep fascia which is incised transversely in its centre The fatty space between the heads of the gastrocnemius muscle is opened and the terminal three inches of the normal short saphenous vein lies between them



FIG. 193

A keloid scar after a longitudinal incision for ligation of the short saphenous vein in the popliteal space. Notice the equinus disability

The transverse incision —A transverse incision usually made somewhat above the skin crease behind the knee gives but limited access to the sapheno-popliteal union and is only justified when its exact whereabouts are known as in a *thin* person It gives an inconspicuous scar

Multiple transverse incisions —When the end of the external saphenous vein has proved to be lower or higher than was expected in several patients another transverse incision tracing the saphenous vein up or down the limb has been used. These healed pleasingly and gave satisfactory access

The S or longitudinal extension of the transverse or curved incision —The exposure of the actual sapheno-popliteal junction is essential In some patients, the short saphenous vein runs alongside the popliteal vein for some one to two

inches before uniting with it, perhaps just below the adductor foramen at the apex of the popliteal space. Even with strong retraction and flexion of the knee, full access to the confluence cannot always be obtained through the curved or transverse incision. More room upwards can be gained by making a longitudinal incision 3 - 5 inches long on the inner aspect of the thigh, beginning at the end of the transverse incision, thereby forming a letter L. The resulting flap is raised and all difficulties of limited exposure disappear. Should more space be required in the lower part of the popliteal space, it can be obtained by another incision from the outer end of the transverse incision vertically down the exterior of the limb, thus making somewhat of a letter S incision (Fig 194)

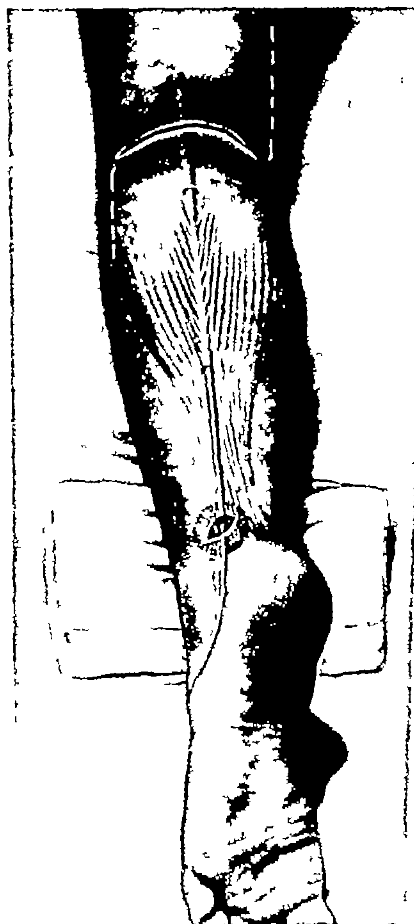


FIG 194
The S incision or longitudinal extension of the transverse incision

The sapheno-popliteal exposure —The chosen incision is deepened down to the deep fascia In women there is often a thick layer of subcutaneous fat, and a large skin wound is required to work at the considerable depth. If the stripper is clearly impacted at the sapheno-popliteal junction and is palpable, the curved incision is made $\frac{3}{4}$ in higher than seems necessary and proceeds as already detailed under this heading It is wise to determine the exact site of the tip of the stripper in the vein by measurement with another stripper

After the external saphenous vein has been found it is cleaned " nude," and traced down to the sapheno-popliteal union The popliteal vein is uncovered for 1 cm above and below this point Sometimes the dissection is sanguinary and tedious, for the popliteal areolar tissue is soft and sticky, and contains several tiny thin-walled friable venules which join the last half centimetre of the external saphenous or the popliteal vein The last 1 - 2 inches of the short saphenous vein may be parallel to and in contact with the popliteal vein either superficially or laterally

The popliteal vein is recognised by its lying on the popliteal artery at the centre of the popliteal space and the latter's pulsation can be felt through it In the upper part of the space it is outside of the artery and in the lower half on its inner side It is straighter, larger, thicker walled and paler than the external saphenous vein. Other fair sized veins lie alongside of it Some are from the gastrocnemius muscle and the posterior tibial venae comites may persist and confuse the recognition of the external saphenous vein Further,

fusiform dilatations may be present on the popliteal vein making it look varicose and thereby adding to the problem of identification.

The popliteal vein is inspected and palpated for the adjacent pulsation of the popliteal artery

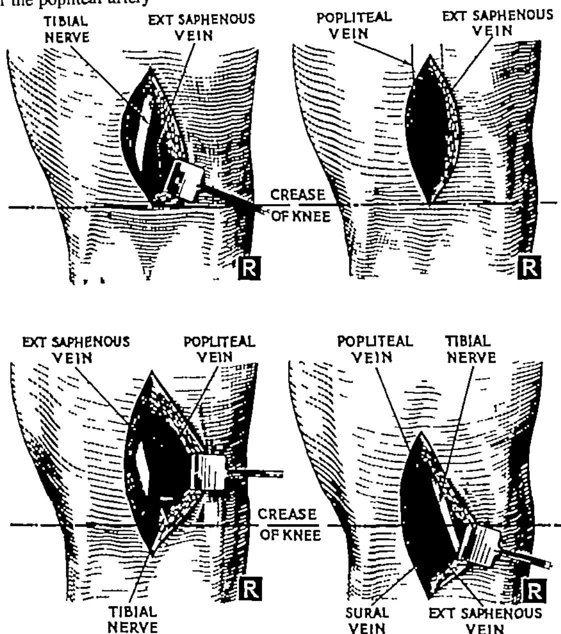


FIG. 195
Four findings at the sapheno-popliteal junction in relation to the knee joint level
The longitudinal incision shown here should never be used !

The nerve (tibial) and its branches lie close at the side of the terminal portion of the external saphena more often on the inner than the outer they are studiously avoided The stripper inside the external saphenous vein is invaluable in its location If it has not been identified by the stripper inside it, as for instance in the case of recurrent external saphenous varicosity which

has been divided lower down the limb, the popliteal space must be opened widely and deeply by the S incision The popliteal vein and artery are found and traced up and down until the external saphenous junction is established. Figure 195 illustrates the findings in four consecutive cases of sapheno-popliteal ligation

The few terminal tributaries of the small saphenous vein are ligated, including those which pass upwards to join the internal saphenous and gluteal veins, for if they remain connected with a source of high venous pressure,

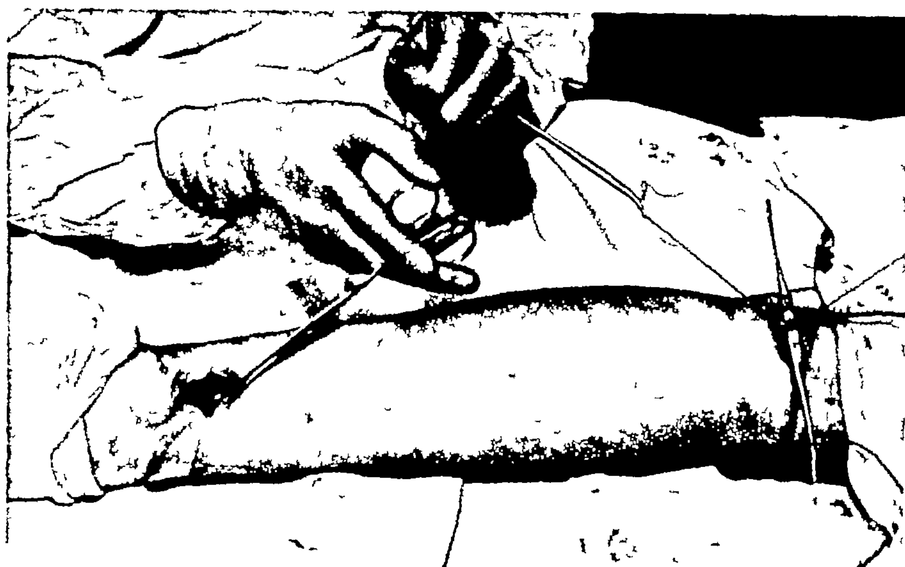


FIG 196
The stripper passed through the external saphenous vein from the ankle to the wound at the popliteal space

they will transmit it to neighbouring veins, and ultimately cause another crop of varices On the terminal 1 - 5 cm of the short saphenous vein, a varix occasionally of considerable size may be found which can be an exercise in dainty dissection A fusiform varix of the popliteal vein is ignored, although it suggests that it is also incompetent No further step such as popliteal vein division is taken This is discussed in Chapter XVII

Stripping the external saphenous vein —When the sapheno-popliteal union is reached the external saphenous vein is tied here twice and divided distal to these ligatures The stripper is pressed upwards from the ankle so that its tip emerges from the cut vein and it is drawn out until its other end is close to the lower wound where a ligature is tied round it and the vein (Fig 196) The vessel is divided distal to this A space is made round the vein for the entry of the stripper shoulder, by dissecting away the fat The "stripper" is guided into the wound without touching the skin. The "clean" method of stripping (Fig 197) is used whenever it is feasible, the ankle incision being closed after the stripper has been drawn in 1½ inches (3 - 4 cm) Steady vibratory traction is made on the upper end of the stripper

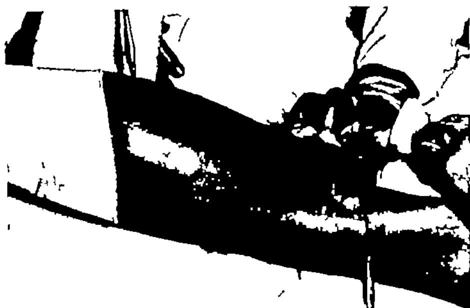


FIG. 197
"Clean" stripping of the external saphenous vein The artery forceps point to the position of the stripping shoulder under the skin The bandage is just behind.



FIG. 198
The stripper has been pulled through from the ankle to the knee. The vein is emerging from the wound telescoped on the stripper notice that the sterile bandage is just short of the wound.

and is continued until the varicose trunk appears as a telescoped fusiform mass on the instrument out of the wound (Fig 198)

The bandaging follows the stripper closely as it passes subcutaneously up the calf (Fig 198).



Fig 199
The leg is pressure-bandaged after the stripping of the external saphenous vein

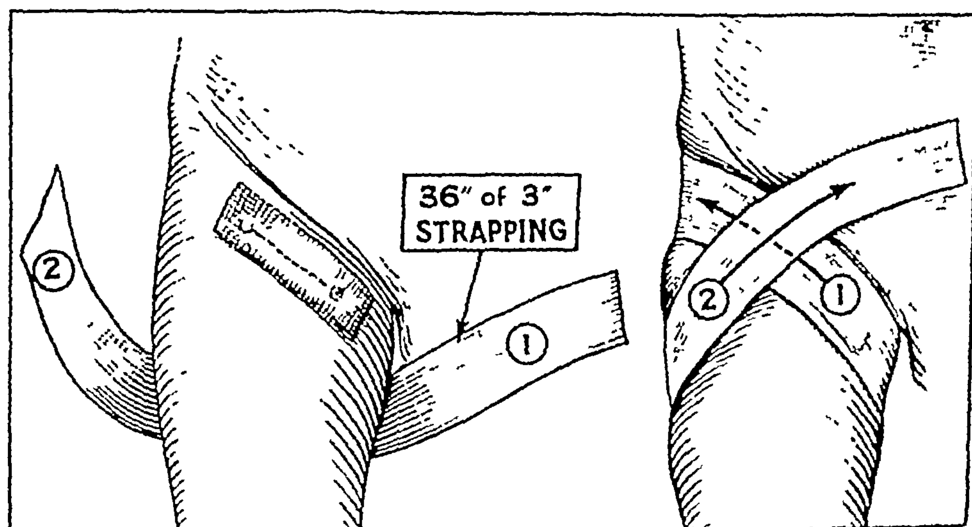


Fig 200
Strapping the wound at the groin with Diachylon strapping (not zinc oxide to avoid a sensitivity rash)

Variations —It is necessary to follow the stripper until the termination of the external saphenous vein is found with certainty An exceptional experience was that of the stripper passing apparently into the saphenous vein as usual The sapheno-popliteal union was cut down upon and at first it was thought that the stripper was in the external saphenous vein which was terminally ligated Then the true external saphenous vein was seen joining the popliteal vein 1 cm higher The stripper was in a direct communicating

vein and had passed through the calf muscles and then into the popliteal vein above the knee joint. A Mayo s (not Myers) stripper was threaded round the true external saphenous vein and it passed down beyond the mid-calf and impacted at the point where the first stripper passed deeply In this way the



FIG 201
The sterile crêpe bandage applied and fixed by strapping.

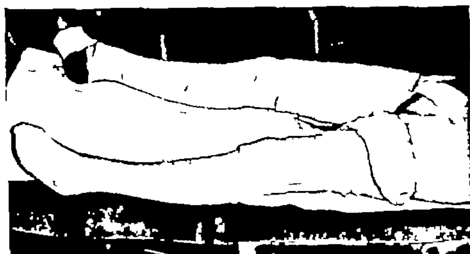


FIG. 202
The limb bandaged by an elastic webbing roll.

whole of the external saphenous trunk was traced and removed This communicating vein was a long oblique one as sometimes seen in venograms

One accident to the popliteal vein in a thin patient must be reported.

A thin man of eighteen had gross bilateral external saphenous incompetence The stripper was threaded from the ankle to the popliteal space and its presence was checked with the finger It was apparently lying in the external saphenous vein which presented when the popliteal space was opened. This vessel was traced up to the upper part of the popliteal space where it appeared to dip

down to join the popliteal vein It was ligated superiorly and divided preparatory to stripping The stripper was brought out of it to the surface The bleeding was immediately profuse, much more than usual and furthermore the vein could not be stripped farther up than the lower part of the popliteal space one inch below the level of the knee-joint, it was fixed although more than the usual effort was applied Because of this obstruction and the excessive bleeding, the situation was investigated It was found that the sapheno-popliteal union was at the lowest point of the popliteal space, below the line of the knee-joint The stripper had passed from the external saphenous vein into the popliteal vein, which had been divided in the upper part of the popliteal space

The external saphenous vein was removed and both ends of the popliteal vein were ligated, so that the patient had his short saphenous vein removed and his popliteal vein divided Fortunately no ill effects followed in two and a half years beyond a little oedema of the ankle in the evening for two months afterwards He was immediately ambulant after the operation This is an example (*a*) of a low sapheno-popliteal union, (*b*) of the unexpected superficial position of the popliteal vein to a thin person, (*c*) of the stripper passing on through the sapheno-popliteal union into the popliteal vein

These incidents parallel the tying of the femoral vein or artery that can occur during the procedure of sapheno-femoral ligation in spare subjects The lesson is to see in every patient the sapheno-popliteal junction and to identify the popliteal vein without any doubt before applying a ligature or haemostat to the external saphenous vein

Conclusion —To recapitulate, there are three essentials in this operation of sapheno-popliteal division —

1. The sapheno-popliteal junction must be clearly seen
2. Implicit in (1) is an incision that will ensure this exposure whatever the position of the union The S or transverse incision extended up or down laterally gives this
3 The mid-line longitudinal incision should never be used.

IMMEDIATE POST-OPERATIVE COURSE AND CARE

The immediate post-operative discomfort after stripping is surprisingly small and our ward Sisters tell us that there is no difficulty in persuading patients to be ambulant immediately (Figs 199, 201 and 202).

1 Before the patient leaves the theatre the firm crêpe or elastic webbing bandage must be applied from toes to thigh

2 The foot of the patient's bed will be raised on blocks while the patient remains in hospital. This is vitally important in the post-operative régime

3. As soon as the patient is fully recovered from the anaesthetic (6-12 hours) active movement of the legs is enforced. He must not lie still in bed He should get up and walk actively for a short time within twenty-four hours of the operation, but his legs must be continuously supported by the webbing elastic bandage from toes to thigh.

By the third or fourth day the patient should be walking fairly comfortably and may safely be discharged from hospital as a rule. Instructions are given that they will need their firm elastic webbing bandages all the time they are up for two to three weeks after leaving hospital. In this way post operative swelling is avoided, the patient kept comfortable and the danger of post-operative thrombosis minimised.

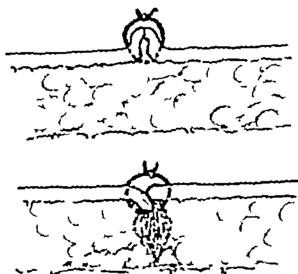


FIG. 203
Closure of the wound suturing the skin the right and wrong way (lower).

Stitches—Closure of all wounds made during varicose vein operations must be done with special care, as many of the wounds in the groin and lower leg are in an area of low tissue vitality. Rough coarse suturing may precipitate wound breakdown and infection (Fig 203). In general stitches should be numerous and small close to the wound edges. Any non-reactive material such as fine silkworm gut or braided nylon is adequate. A subcuticular monofilament nylon stitch may be used (Figs. 204 and 205). Stitches may be removed from the small transverse incisions in the groin in from five to seven days. In the larger incisions, particularly those in the leg, the "hockey-stick" groin incision and those in the popliteal fossa it is wiser to leave them ten to fourteen days. Sometimes if they are left in too long they themselves become a cause of sepsis and sticky discharging wounds.

It is of vital importance to healing in all incisions on the leg in varicose vein operations that they should be under continuous pressure from an elastic bandage. This same bandage is all that is needed to keep the dressings in place, thus avoiding sticking plasters containing zinc oxide and rubber which

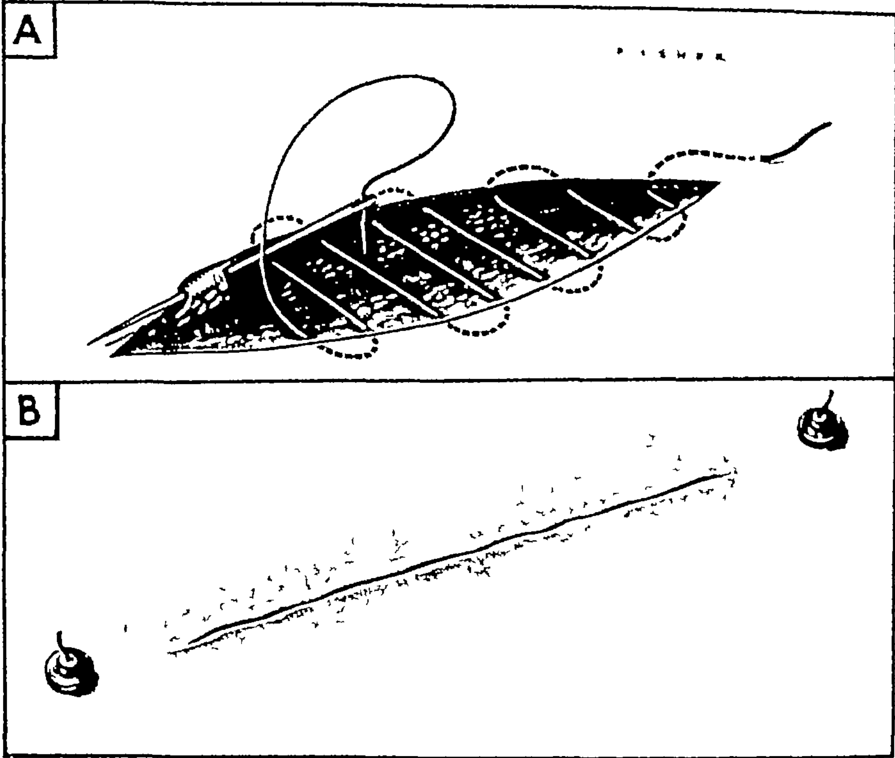


FIG 204
The subcuticular stitch (monofilament nylon)

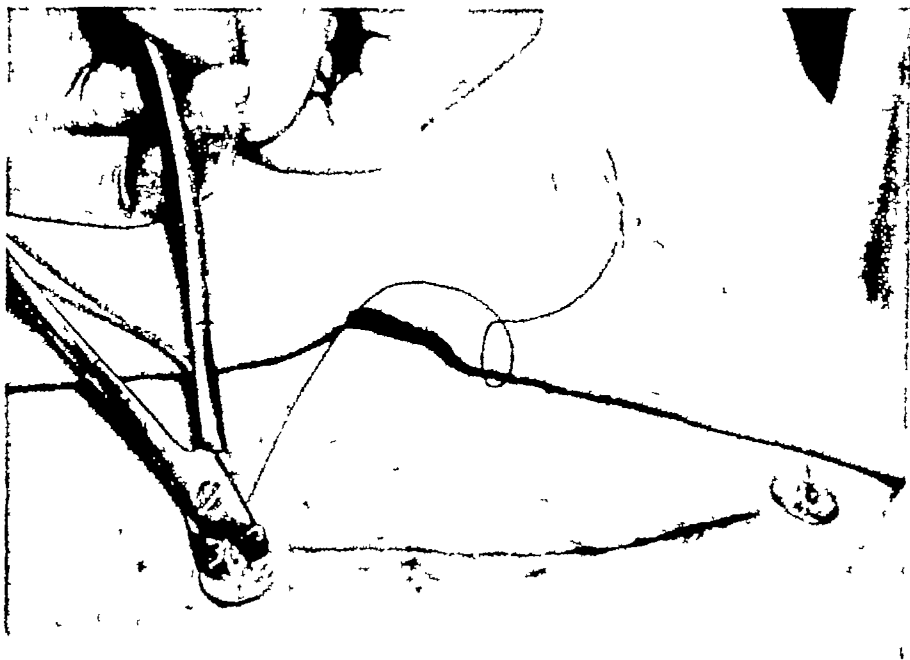


FIG 205
Securing the subcuticular stitch by crushing a soft metal button on each end

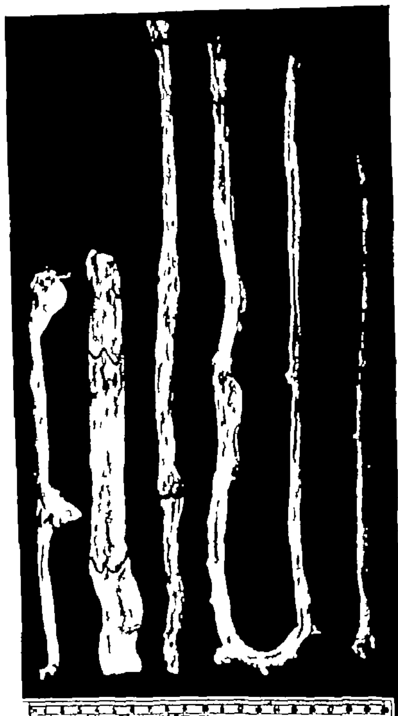


FIG. 206

Three stripped veins. From left to right they show (*a*) a fragmented internal saphenous: it was broken at the knee. The first vessel is the unopened upper portion, the second is another portion opened, whilst the third is the internal saphenous vein below the knee. (*b*) The fourth specimen is a completely stripped internal saphenous vein. (*c*) The vessel on the right is an external saphenous vein

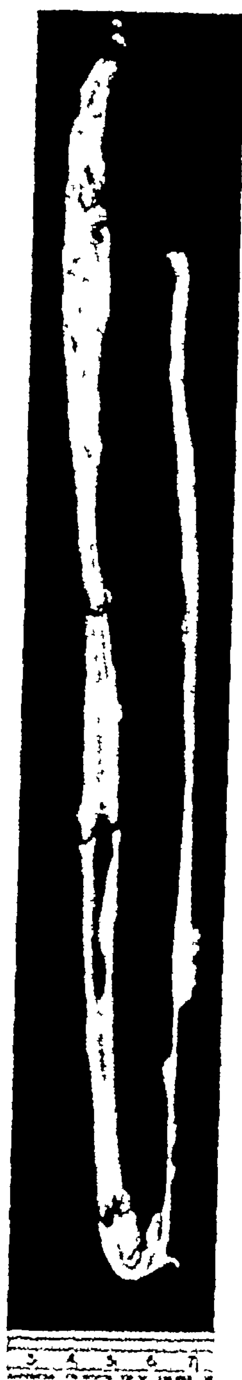


FIG 207



FIG 208

FIG 207—A stripped long internal saphenous vein ; it has been opened It shows loss of part of it in the region of the knee and also a firmly adherent thrombus The edge of the valve cusp has been marked with ink

FIG 208—Illustrating two stripped veins (laid open) That on the left is a recanalised thrombosed vein and the other an average varicose vein Note that the left is lighter in colour (i e it is more fibrous), it has several channels as illustrated by the bristles inserted into them It is thickened and fat is adherent to it from periveniitis The other vein is a large thin-walled vessel with two valves showing faintly.

often give rise to skin reactions locally and more widespread A circle of diachylon strapping is well tolerated however

THE VENOUS TROPHY —When the telescoped vein on the Myers stripper is extended a varying length is revealed which has the stumps of several avulsed tributaries 2 4 cm long attached to it (the entire saphenous trunk may measure 24 28 inches (60 70 cm) (Fig 206) On examining the vein it may be found to be complete Sometimes a portion of its wall, especially about the knee level, for several centimetres is torn away (Fig. 207) presumably where a tributary has proved to be stronger than the parent stem The vein may be in two pieces where a subordinate vessel has retained an entire piece of the saphenous trunk (Fig 206) Many varicose veins have been injected with sclerosing agents so that they are perhaps anchored by scar tissue. Retained segments are not sought for at the operation they are easily dealt with by sclerosing injections subsequently we have never found it necessary to excise them Occasionally the vein is found to be turned inside out, the stripping shoulder having been pulled inside a very dilated trunk gentle traction on the inverted vessel usually extracts it entire.

THE INTERIOR AND VALVES OF STRIPPED VEINS —The removed vein is opened and its lumen and valves are inspected The lumen may be clear and patent but it is easy to recognise a vessel which has recanalised after thrombophlebitis for in it are numerous interlacing white fibres passing in all directions from the wall, especially about the valves (honeycombing describes it well) it demonstrates how a deep vein re-opened after thrombosis must always be incompetent. There may be one or more complete longitudinal septa for several centimetres across part of the vessel making two or occasionally three passages (Fig 208) A thrombus completely or partially occluding the lumen may be present it is usually firmly adherent to the vein (Fig. 207) Only a few have been seen and they were distal to a valve. The valves after thrombophlebitis are disorganised with irregular clumps of slightly pink fibrous tissue and the cusps have disappeared.

Varices —Eccentric dilatations are frequent on the saphenous trunk situated at a valve. They stimulate thought as to their formation They are sometimes immediately distal to the valves, occasionally they are proximal and in several specimens there has been an eccentric dilation above and below a valve cusp

A varix forming above a valve is understandable as arising from excessive thoraco-abdominal pressures exercised on the vein wall just above the closed valve and the vein wall yielding.

A varix below the valve is more difficult to explain (Fig 209) The yielding may occur at the valve ring itself between the attachment of the cusps and the direction of the varix above or below is then fortuitous It is an interesting question which is fundamental in the development of varicose veins. The yielding of a valve ring would be an acquired form of varicosity

THE VALVES.—The valves found in the removed varicose saphenous trunks are mostly bicuspid and of three types (*see* Figs. 206 209)

1 *Major valves.*—There are one or occasionally two strongly developed valves in the terminal 1 2 inches of the internal saphenous trunk (2 5 5 cm). Occasion

ally another such valve occurs below the entry of the large tributaries at the knee There is a well-marked dilatation of the vein above them

2 *Ordinary valves*—There are a varying number of more delicate but apparently complete valves ranging from one to eight from the groin to the ankle Their cusps are delicate, there is no apparent valve ring as in the major valves, nor is the vein dilated above them

3 *Ghost valves*—These are barely visible There may be a suggestion of cusps but as a rule there is but a faint V mark on the endothelium, suggesting either an imperfectly formed valve or one which has disappeared leaving only the line of attachment of the cusps to the wall

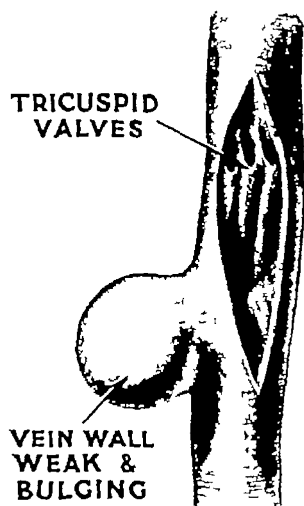


FIG 209
An artist's drawing from a specimen showing a tricuspid valve and a varix distal to it, both are somewhat unusual

The valves are demonstrated by trickling a fine stream of water on the opened vessel opposite to the direction of blood flow This floats the cusps outwards and causes the water to eddy or bounce back as it impinges on them

On a few occasions, a tricuspid instead of a bicuspid valve has been observed (Fig 209)

The number of valves found in the varicose internal saphenous trunks varies from two to eight In twenty-eight complete specimens of the internal saphenous trunks examined from seventeen women and eleven men the average number of valves was five The highest number was thirteen, one had ten, two had eight, three had seven, four had six, two had four, three had three, and the remaining eight had two The average number of valves was five and a half in the men and four and a half in the women The valves are more frequent in the leg portion than the thigh

The varicose external saphenous trunk has proportionately more valves, although it is but half the length of the internal saphenous trunk The average of ten stripped specimens being 4 3, the highest number being seven and the lowest two

The difference between these two is a further factor perhaps explaining the greater frequency of incompetence in the long saphenous vein, for the external saphenous vein, being but half the length of the internal saphenous vein, has in the specimens we have examined almost the same number of valves

Injection of stripped trunks—Some of the trunks of the stripped saphenous veins have been injected retrogradely after ligating the snapped tributaries Two findings have been noted First, that of undoubted varicosity of the entire trunk to the ankle and, second, in some specimens the incompetence has been partial Thus, in one internal saphenous trunk the fluid would not pass beyond the union of the anterior and posterior leg tributaries, below the knee it was sound In one external saphenous vein it was found to be sound below the centre of the calf This partial incompetence of the trunk of a varicose system will explain some variation in the physical signs and symptoms

DIFFICULTIES AND DANGERS OF THE OPERATIONS

Difficulties and dangers of terminal sapheno-femoral and sapheno-popliteal ligation.—Most of the operative troubles arise from two causes (*a*) failure to obtain an adequate exposure (*b*) failure to appreciate the variations of venous and arterial anatomy to be found during both sapheno-femoral and sapheno-popliteal ligation

The saphena varix (*see* Fig 177)—A saphena varix varying in size from a marble to a walnut, is fairly frequent on the terminal two to four inches of the internal saphenous vein and also but less often of the short saphenous vein It is usually a saccular dilatation but can be fusiform it seldom affects the last centimetre of the vein With equal frequency it is on the antero-external vein of the thigh A varix may be present about the union of the internal saphenous and the postero-internal vein perhaps four to six inches below the sapheno-femoral junction Occasionally there is one on the superficial external pudic vein. We have never seen one precisely at the sapheno-femoral point and this may be because there is a process of femoral sheath around the terminal half centimetre of the saphenous vein

Bleeding from a torn varix—Varices are disconcertingly friable and the copious bleeding that occurs when they are torn compels gentleness and alertness In spite of care a varix or large vessel may be torn by a slight touch and the bleeding may be profuse. The remedy is to press a pad firmly into the wound for two minutes (by the clock) and to tilt the operating table into the Trendelenburg position The venous pressure and haemorrhage are thereby much reduced. The swab in the wound is rolled aside slowly and the bleeding point or points, as they are revealed are under-run twice by a fine stitch and tied If the varix is grasped by even light weight haemostats, they often tear away and the dilatation is injured further We have had this testing experience and the haemorrhage has tried us to the utmost Trying to clip the bleeding point in a pool of blood is dangerous it may lacerate the femoral vein and less often the artery is inadvertently damaged

Another remedy is that of a sucker which will remove the blood as rapidly as it issues and thereby reveals the exact site of the tear allowing it to be accurately under-run with a double stitch

Patience, gentleness and a wide dissection ensure freedom from accidents in this operation

Duplication of the internal saphenous vein.—A rare abnormality is the real duplication of the internal saphenous vein (Fig. 210) An apparent duplication is usually due to an enlarged straight postero-internal vein joining it close to or at the sapheno-femoral union instead of the usual 2 15 cm lower

Division of the common femoral vein—This vein has been mistaken for the internal saphenous vein and ligated especially in thin subjects On three

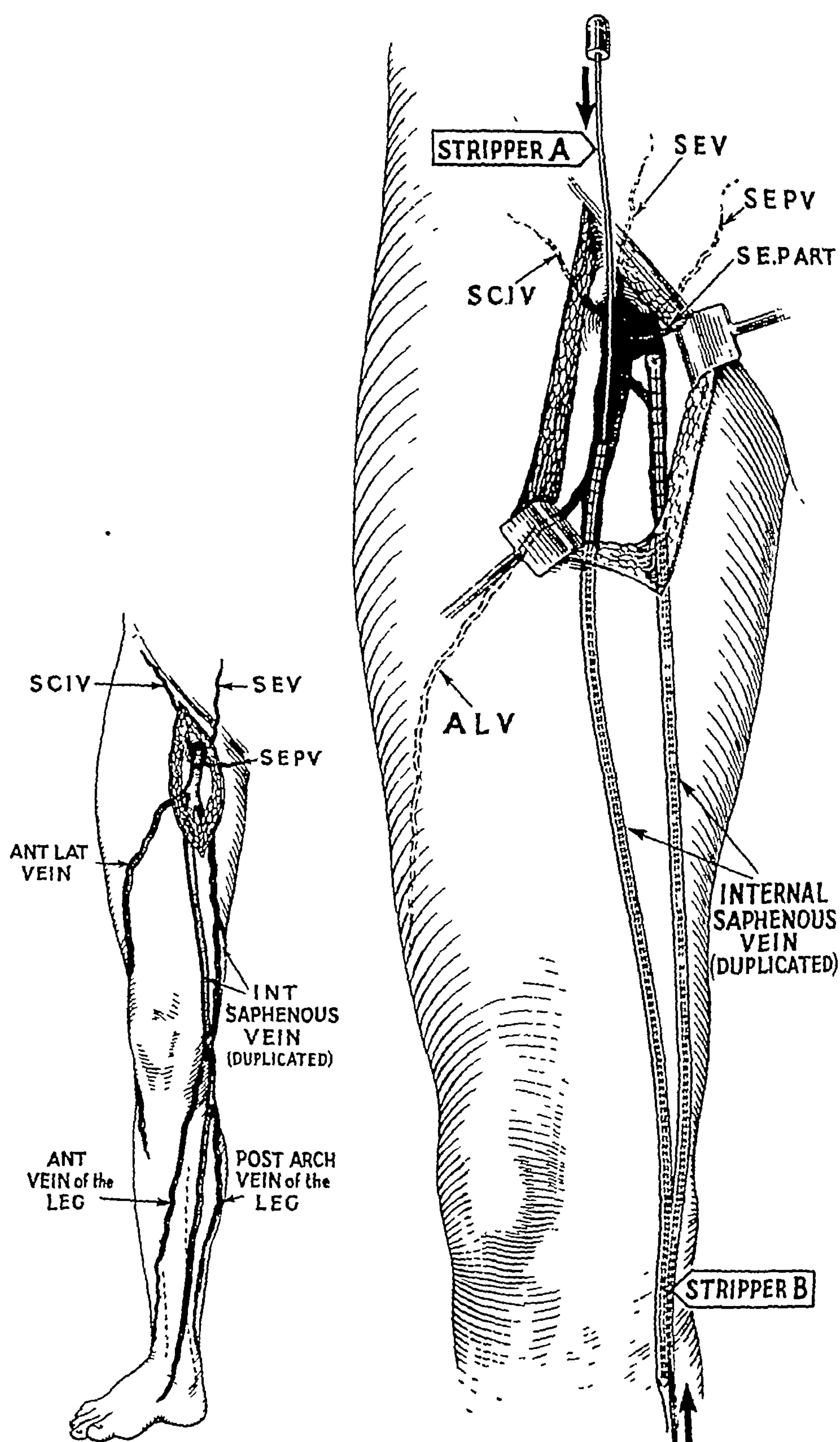


FIG 210
Two cases of true duplication of the long saphenous vein which we have met

occasions one of us was on the point of ligating it before realising the error whilst on a fourth it was tied and injected retrogradely with sclerosing fluid Because the vein continued to be distended and did not collapse as does the varicose internal saphenous vein after ligation, the mistake was retrieved The situation was treated by temporarily occluding the femoral vein superiorly opening it distally between stay sutures, and allowing it to bleed for five to ten seconds, thereby discharging the sclerosant no clots were seen to emerge. The volume and power of its circulation was impressive The vessel was sutured and no incident either immediate or remote followed.

Injury to the common femoral vein—This usually occurs from flurried attempts to stem bleeding from a torn saphena varix. The torrential bleeding which occurs from a side hole in the femoral vein can be stopped immediately by the tip of the gloved finger placed directly on the spot. While the assistant s finger is continuously so held the table is tilted so that the legs are elevated and the wound is enlarged. The femoral vein above and below the foramen ovale is steadily exposed. The fingertip pressure is transferred to directly above and below the site of the tear which will then usually reduce the leak to a trickle, which it is easy to see and deal with by a lateral suture of fine thread or silk on an ophthalmic needle The procedure takes time and gentleness. Bleeding from the upper external saphenous vein or saphenofemoral junction may require this method as when a very thin tributary joining precisely at the sapheno-femoral union tears with a slight touch

Injury to the femoral artery

(*a*) *Injury*—Accidental injury of the femoral artery is handled by the same technique as the sectioned femoral vein Indeed in the older patient the restoration of the arterial flow is essential if gangrene is to be avoided In those younger the vitality of the limb may remain after ligation of the femoral artery but its repair is better

(*b*) *Ligation*—Another accident (personal communications from various surgeons) is that of ligation and injection of the femoral artery which has necessitated amputation of the leg in some patients. At first sight it is hard to visualise the perpetration of this mistake but, as already mentioned, in 1951 in a very thin man one of us almost committed it for the femoral artery was dissected out for two inches before it was realised that it was *not the internal* saphenous vein The absence of tributaries led to its closer inspection and the recognition of pulsation

A large accurate incision, a good light and deliberate operating will avoid this catastrophe It is noteworthy that the femoral and popliteal vein and artery are surprisingly superficial in thin persons.

High bifurcation of the femoral artery—As mentioned in Chapter III the femoral artery occasionally divides into its superficial and profunda branches immediately below Poupart s ligament. The profunda artery passes

downwards and inwards over the femoral vein, and above or under the sapheno-femoral junction, the internal saphenous vein being separated only by the anterior layer of the femoral sheath It is an impressive presentation and the profunda artery could readily be injured if the sapheno-femoral junction were approached roughly and through a small incision , Figure 25 (Chap III) shows a recent finding of this condition

Difficulties and dangers of stripping

The bulk of the stripped vein —One of us was unable to pull the stripper from the groin to the ankle because the bulk of the telescoped vein was so large at the middle of the leg that the fat and skin would not stretch sufficiently for it to pass An incision was made over the protrusion, the vein was brought out and divided from the remaining saphenous trunk, the stripper was re-inserted and the removal completed This is a further reason for stripping upwards for the skin of the thigh is more accommodating as the bulk of the vein increases, and also the groin incision is larger

Passage of the stripper into the femoral or popliteal veins —One must be always aware of this possibility Interesting and significant variations were when the stripper ran by way of a large direct communicating vein into the popliteal (once) and femoral vein (twice) The latter happened in cases of apparent internal saphenous incompetence The stripper passed from the ankle to its full length but it did not appear in the saphenous vein at the groin It was ultimately felt in the femoral vein Palpation of one saphenous trunk revealed that the instrument dipped deeply at middle of the thigh A large direct communicating vein between the internal saphenous and femoral vein was found and divided after the stripper was partially withdrawn Communicating veins are usually linked to tributaries of the internal saphenous veins rather than directly to its main trunk as in this patient, although the perforating vein passing into Hunter's canal is one of the few that can pass directly

In the second person the stripper entered a large direct perforating vein in the lower third of the leg In the third case the stripper passed into the popliteal vein by a direct communicating vein from the middle of the calf

Inversion of the vein —With a stripper with a small shoulder or a very large varicose trunk, the shoulder of the stripper may pass into the vessel's lumen and turn it inside out, but even so, with careful, gentle traction on it, the trunk will strip out completely Usually this accident is not recognised until the venous trophy is drawn from the wound

Pulling the stripper through the vein —When a varicose vein is very large, and the ligature round the vein and stripper has been omitted, the stripper may be pulled through the vessel without removing it The modified Myers' stripper with a larger shoulder and a concave face has prevented this.

Copious haemorrhage —Free, even occasional torrential, arterial-like bleeding may issue from the track of a vein just removed It almost always

subsides on tilting the patient into the Trendelenburg position and applying pressure as by a rolled towel to the empty vein bed On no occasion has it been necessary to find clip and tie such a bleeding vessel

The "clean" method of stripping controls and minimises this blood loss.

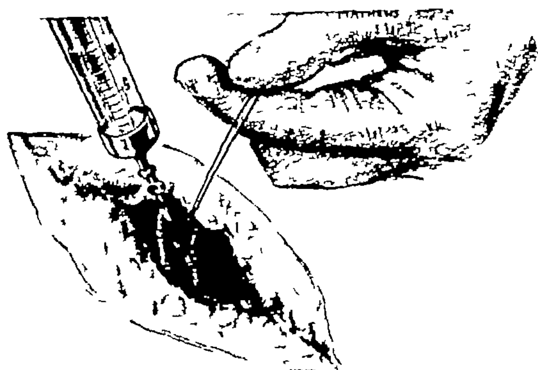


FIG. 211

The direct injection of a sclerosant into the internal saphenous vein or one of its large varicose tributaries. *Note* never more than 3 ml.

One operation of continuous torrential bleeding merits description. An extra incision had been necessary in the mid-thigh. After stripping from the ankle, blood gushed from the thigh wound Pressure was applied to the vein bed and the wound was sutured the patient was in the mid-Trendelenburg position. Blood continued to pour from between the stitches. An injury to the femoral vein was suspected such as might occur by dragging a direct perforating vein out of its side The stitches were removed. In order to see and enlarge the incision as blood poured from it, the assistant raised the limb high from the table when surprisingly the bleeding stopped as if a tap had been turned off nor did it start on lowering the leg a minute or two later

Rarely the bleeding may be out of proportion to the extent of the operation but in torrential bleeding after stripping, try the effect of raising the leg 60 70 degrees from the horizontal for one minute and apply the compressing bandage in the elevated position.

A thrombosed saphenous trunk.—On a few occasions when the saphenous trunk was exposed at the groin, it was found to be thrombosed from an undiagnosed recent attack of thrombophlebitis An effective and safe treatment for this after the terminal sapheno-femoral ligation is not to strip it but *to inject slowly 3 ml of sclerosant into the thrombosed vessel* (Fig 211 *see* Chap II) We think it inadvisable to strip a thrombosed vein lest a continuation of the clot in a communicating vein be dislodged by the trauma of the stripping or stimulated to propagate into a deep vein with the attendant

risks of embolism and deep thrombophlebitis One patient did have a small non-fatal pulmonary embolus after stripping an undiagnosed thrombosed vein

Large tributaries of the internal saphenous vein—Occasionally the stripper as it passes down the trunk will wander into a large tributary It may be into the postero-internal tributary (accessory saphenous vein) and the instrument appears in the popliteal space If this is detected, attempts are made to rectify it by withdrawing and re-directing the stripper The apparent duplication of the internal saphenous vein below the knee has been mentioned and the instrument may pass down to the tendo-Achillis by the posterior arch vein or across the front of the leg towards the external malleolus by way of the anterior vein of the leg, all these large varicose veins may be stripped with advantage, but the removal of the entire saphenous trunk is also essential

The use of sclerosants at varicose vein operations.—Opinions have differed concerning the use and danger of injecting sclerosing fluid into the varicose saphenous vein at operation, so the pros and cons must be examined The purpose of such injections was to destroy the incompetent trunk (and tributaries) of the internal and/or external saphenous vein, after their separation from the deep veins

Retrograde injections and the deep veins—Boyd and Robertson (1949) and Kinmonth (1947) have shown by venograms that if in the supine patient *sufficient* (5 - 20 ml) radio-opaque sclerosant fluid is injected retrogradely into the internal saphenous vein at the groin, some of it passes quickly into the superficial femoral and popliteal veins and tends to be held up at their valves Obviously injury to the delicate valve endothelium is possible with valve destruction or deep thrombosis and embolism These are serious possibilities

Because of this risk, most surgeons have discontinued sclerosant injections at operation, preferring to give them later, when the danger is minimised by giving small doses and the patient is ambulant The operation of stripping has made the retrograde injection of the saphenous trunks an obsolete procedure

Our only use for a sclerosing injection at operation is when (*a*) the antero-external tributary at the groin is grossly varicose, we then insert 2 to 3 ml into it after dividing its termination (Fig 211), (*b*) when, as already mentioned, the long saphenous trunk is unexpectedly found thrombosed, after the saphenofemoral ligation and division, we then inject it with a sclerosant (2 to 3 ml) rather than strip it

Operation for bilateral varicosities.—Provided the patient is *fit*, operation on both legs may be done at the same session However it is important that each leg should be done separately as a separate operation If two operators attempt to " do a leg each " at the same time, the result is usually a certain amount of confusion and breaches of technique Each leg is treated as an

independent operation and the surgeon changes his gloves and re-towels for the second side. If this is not done the incidence of septic wounds rises noticeably (For this reason and to minimise the risk of thrombosis, one of us H D usually does only one limb per session.)

If these precautions are faithfully observed, there is no reason why the short and long saphenous veins and/or the perforating veins should not be dealt with at the same operation Great care must be exercised in turning patients while under an anaesthetic for many of them are old and osteo-arthritic and post-operative lumbago" or "stiff neck" may be caused by rough handling of such unconscious persons

Varicose veins in pregnancy—Varicose veins in pregnancy are a common problem Oddly enough the veins enlarge more rapidly and give more trouble in the first three or four months of pregnancy They often decrease in size and give less symptoms from the fourth to the eighth month after the uterus has risen from the pelvis.

These varicose veins of pregnancy are of three well defined clinical varieties.

1 In the patient who already *has* valvular incompetence of the great or short saphenous system or communicating veins pregnancy usually produces a sudden marked increase in size and number of the varicosities—sometimes to an alarming extent. These patients have large dilated saphenous trunks and large varicosities with an obvious cough impulse in them and a positive Trendelenburg sign

Pressure bandaging from the toes to groin especially in the early months of pregnancy is most necessary in these cases If the mother is fit and the pregnancy between the third and sixth month full sapheno-femoral ligation and stripping is the best way to relieve the patient and prevent gross and distressing deterioration of the veins of the leg (Dodd 1949)

2. The patient who develops a network of smaller dilated veins, mainly below the buttocks and over the thighs and upper part of the legs, but without the signs of gross valvular incompetence of the saphenous system This type is particularly severe in the first three months, and tends to lessen in severity after that. The treatment is rest and elastic support during pregnancy and re-assessment six months after parturition.

3 *Vulval varicose veins*—These sometimes reach an enormous size and may bulge threateningly out of the skin of the vulva like an over-ripe grape They should be treated entirely on their merits if they start decreasing in size after the 3rd 4th month they will not give trouble If they steadily increase in size and become large and tense they should be excised by operation and their "feeding" veins traced This may lead to (*a*) the sapheno-femoral junction in which case a full sapheno-femoral ligation should be done (*b*) an incompetent communicating vein passing under the lower edge of

gluteus maximus or into the postero-internal aspect of the upper thigh These are divided

General principles—It is astonishing how some of the grosser cases of pregnancy varicose veins fade completely away during the puerperium and give little trouble later The treatment of pregnancy varicose veins is dominated by this fact Thus the general principles are —

1 *Pressure*—Firm elastic support of the legs and thighs, either by webbing elastic bandages or heavy elastic stockings, throughout pregnancy and for the first month or so of the puerperium (this is important to avoid post-partum thrombosis, superficial or deep)

2 *Elevation of the legs*—Short periods of rest, reclining with the legs at a higher level than the patient's heart, during the day The foot of the bed should be raised on six-inch blocks at night

3 *Ligation*—Operation is indicated only in the grosser cases showing obvious signs of valvular incompetence

4 *Follow-up*—All cases should be seen three to six months after delivery for the routine clinical assessment of the condition The decision whether to operate then is made on the merits of the case, influenced to some extent by a strong family tendency to varicosities and whether further pregnancies are desired or likely Even minor degrees of saphenous incompetence should be treated operatively if further pregnancies are possible, as varicose veins get worse with each succeeding cyesis

Operations during pregnancy.—These, when they are necessary, should be timed between the third and the sixth month Progesterone (10 mg t d s) and Vitamin E (Ephynal) (10 mg t d s) should be given for three days prior to and for ten days after operation Operations before the third month carry the risk of abortion, operations after the sixth month carry the risk of foetal anoxia and premature birth These risks are admittedly slight, but they are present

OPERATION FOR INCOMPETENT COMMUNICATING VEINS

Incompetent communicating veins are sometimes striking in their size They may be the only source of retrograde filling of subcutaneous varices but they often occur with defects of one or both of the saphenous systems, and are a manifestation of some deep vein incompetence Inefficient communicating veins may cause " blow-outs " on varices, especially in the lower thigh and leg Their ligation or ligations are often required to assist in alleviating oedema, eczema, ulcer, severe pain or recurring varices around and above the ankle This is fully dealt with in Part III of this book

There is a constant large communicating vein in the lower third of the thigh passing to the femoral vein by Hunter's canal (Figs 40 and 41) This is occasionally the cause of primary or recurrent varicose veins and occasionally

requires location and ligation A venogram is very useful in these cases. Another one which is occasionally incompetent is that immediately below the inner aspect of the knee (Fig. 20 Chap III)

Incompetence of these veins is relatively rare compared with the commoner incompetence of the great and short saphenous veins, and of the ankle perforating veins.

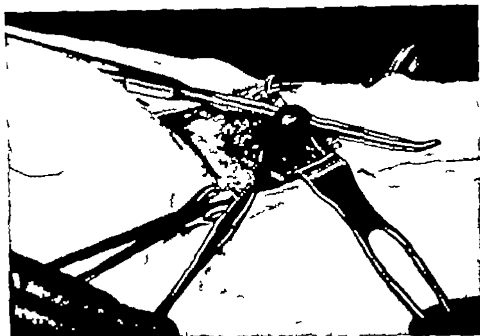


FIG. 212
The ligation of a communicating vein causing a varix on the outer side of the thigh.

They are divided between ligatures at the level of the deep fascia Large varices about them are excised or injected with 2 to 3 ml. of a sclerosant followed by pressure bandaging for two weeks Patients get up immediately as after other operations on varicose veins.

Figure 212 shows the operation on the varix shown in Chapter VI Figure 84 This vein passed through tensor fasciae femoris which is an unusual site for a perforating vein.

MULTIPLE LIGATIONS —We consider multiple ligation of the varicose saphenous trunk to be inferior to stripping.

We have performed several operations for recurrent varicosities after *so-called multiple* ligation procedures we had no difficulty in threading the stripper through the saphenous trunk from the ankle to the groin showing that the procedure is technically uncertain.

"The practice of multiple ligation of the veins through short incisions without any attempt to locate incompetent communicators is to be condemned as a waste of time for everyone concerned" (Muir *et al* (1954)) We subscribe to this

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CHAPTER IX

POST-OPERATIVE COMPLICATIONS, AFTER-CARE AND RESULTS

POST-OPERATIVE complications.—A well-carried-out sapheno-femoral ligation and stripping, with proper pre-operative and post-operative care is one of the most trouble free operations of Surgery Nearly all the complications are due to either lack of care at operation or to inadequate after-treatment.

1 *Pain*—Pain should not be a problem after sapheno-femoral ligation and stripping. If the patient complains of pain a search should be made for some cause, such as sepsis or deep thrombosis.

2 *Haematoma*—In view of the many vessels lacerated during stripping, a haematoma would be a reasonable expectation Provided the operation is done with the foot of the table raised, and firm pressure bandaging from the ankle to the groin is carried out in the immediate post-operative period it is very rare.

3 *Post-operative discoloration of the skin*—Some amount of bruising along the course of the saphenous vein bed is almost an invariable occurrence It varies considerably and it may alarm patients and the nursing staff Some times it takes up to 4 5 weeks to disappear completely It always does disappear! The immediate pressure bandage minimises it.

4 *Post-operative saphenous neuritis*—This is a common complica tion after saphenectomy After a great saphenous strip the patient nearly always complains of a feeling of numbness or tingling over the inner side of the ankle or foot. After a short saphenous strip the paraesthesiae are over the outer border of the foot and ankle.

Sometimes there is anaesthesia of a small area Occasionally the patients complain of actual pain in the region Usually these symptoms pass off within a few weeks and we have never seen a case where persistent neuritis has been a problem. These symptoms are due to bruising of the saphenous and sural nerves by the passage of the stripper and the dissection of the saphenous vein trunks at the ankle

5 *Wound sepsis*—The wounds at the groin popliteal space and ankle are prone to become " sticky and often heal slowly particularly in the obese. This is partly due to defective pre-operative preparation and operative tech-nique. The operation for varicose veins, being one of convenience, must be done with first-class technique, precisely the same as for abdominal or joint procedure.

General debility or tissues impaired by intertrigo ulceration eczema or oedema also play a part The wounds progress better when they are lightly and firmly dressed with gauze and a cotton bandage or a strip of ventilated strapping without wool With neat secure dressings, shoes and stockings

can be worn, and patients can walk or should be willing to try A bulky dressing promotes a feeling of insecurity and encourages immobility. A loose application is easily displaced and infected

Sepsis is more liable to occur in the obese, and in those who have had ulceration or eczema It is introduced by faulty technique or from injury to infected saphenous lymph nodes and capillaries Asepsis, haemostasis and obliteration of dead space will largely prevent it Operation should be delayed until intertrigo, ulcers and eczema are healed or have been in a healthy state for at least two weeks The early removal of stitches to relieve tension or to let out pus will give relief

Localised periphlebitis.—Periphlebitis and thrombosis of the superficial varices, with oedema of the subcutaneous tissues and overlying skin, may cause considerable superficial swelling after any treatment of veins, whether it be ligation, injection, stripping, etc It is due to the trauma of the operation and is fairly common It is more likely to occur in gross veins and occasionally is widespread and severe in degree It is associated with an increased pulse rate, raised temperature and often much pain It is relieved by sedatives and a compression-supporting bandage of stockinette or elastic webbing re-adjusted morning and evening The leg is usually affected, but occasionally all the track of the internal saphenous vein is involved, then the limb from the toes to the groin is enclosed Compresses of glycerine and belladonna applied to the painful area are soothing If the oedema is slight, an elastic stocking will suffice Increasing activity, as far as the local condition permits, is essential

Occasionally, a little fluid collects under the skin, but it is almost invariably absorbed Very rarely the skin may necrose for a small area over thrombosed veins, and this is allowed to separate and granulate It always heals uneventfully and is treated by infrequently changed pressure dressings, preferably of Diachylon

A lymph collection in the groin.—A few patients have had a considerable collection of lymph in the groin, after saphenous femoral ligation and stripping They were singularly inert swellings and continued unabsorbed for two months, in spite of pressure bandaging One was the size of a golf-ball and the other of a tennis-ball They were mobile, painless and fluctuant They were relieved by aspiration through a large-bore needle; the larger swelling required it twice They contained straw-coloured clear fluid

Deep thrombosis after operation.—A serious post-operative complication after the treatment of varicosities is thrombosis of the deep veins In our experience, it is rare, rarer for instance than after other surgical measures, such as herniotomy, prostatectomy, cholecystectomy, renal procedures, etc We believe the frequency of this complication has been somewhat exaggerated although its importance and danger cannot be over-emphasised A few of our patients have suffered from painful swelling of the leg (not of the thigh)

which lasted one to two weeks The pain was in the calf muscles the dorsum of the foot ankle and leg were moderately swollen the leg muscles were firm and walking was painful It is considered that there was thrombosis of the intramuscular veins and possibly of part of the posterior tibial venae comites These legs were firmly bandaged the patients were encouraged to walk, and sedatives were given as necessary to relieve the pain during exercise and to assist sleep The discomfort and oedema subsided in several days with restoration of function and satisfactory results from the varicose vein operation during observation for one to ten years have followed

One of us has seen phlegmasia alba dolens once after a varicose vein operation it was in January 1953 after stripping of the internal saphenous vein at least 5 000 patients were cared for in this period (*see also* Chapter XII)

Precautions against post-operative thrombosis.

1 Patients with varicose veins are operated on only when they are active and in good health this is an operation of convenience, seldom of urgency !

2. The sepsis of active ulceration and eczema is cleared up first.

3 Sclerosants are not injected at operation.

4 The operating table is tilted head-down to assist the venous return from the legs quickly flowing blood is unlikely to clot. For the same reason, the foot of the bed is raised for at least forty-eight hours.

5 Patients are encouraged to move the legs in bed soon after operation this is essential as many keep them still from apprehension and pain. They get up the same day with the legs pressure-bandaged.

6. The calves of the legs as well as the pressure points are massaged during the first twenty-four hours after operation to encourage movement and to assist the venous circulation.

7 Patients may walk after operation but standing and long sitting with the legs down is avoided for ten to fourteen days.

Embolism after operation for varicose veins.—Pulmonary embolism after operation for varicose veins is a rare complication In the series of over 3 000 personal patients no fatal case has occurred In twenty-five years, several patients have suffered from "medical emboli" which occurred when they were at home, for they are not hospitalised for more than two to three days The embolus developed suddenly seven to fourteen days after the procedure and was usually diagnosed as a chill or pneumonia One patient was brought back to hospital with a pleural effusion which subsided uneventfully after aspiration

Pulmonary embolism (non-fatal) after stripping varicose veins—By the courtesy of Professor J B Kinmonth we are able to quote the following after stripping operations for varicose veins —

	Cases	Embolism
St Thomas's Hospital, London (1949 1954)	204	1 (0·5%)
St. Bartholomew's Hospital, London (1950 1954)	157	1 (0·6%)
University College Hospital, London (1954 Bolton Carter)	237	1 (0·4%)
Mayo Clinic, Rochester U.S.A. (1947 1951 Myers)	711	3 (0·4%)

One of us had one case in 471 patients, *i.e* 0 2 per cent. (1952 - 54)

Following general surgical operations, the following are representative figures for comparison (Kinmonth) —

	Cases	Embolism
St Bartholomew's Hospital, London (R S Murley, 1950)	1,289	6 (0 5%)
Mayo Clinic, Rochester, U S A (1928 - 1950)	158,200	(0 6%)

Fatal pulmonary embolus—A fatality from a pulmonary embolus after a varicose vein operation was reported in the public press in April, 1954 A man of 46 suffered from a varicose internal saphenous vein, ulceration of the leg and had had several attacks of superficial thrombophlebitis A sapheno-femoral ligation and retrograde sclerosing injection into the internal saphenous vein were performed as an out-patient He returned home the same day He progressed uneventfully

A week later, when en route to hospital for a routine check-up, he died from a pulmonary embolus At the post-mortem, the sapheno-femoral ligation was clear but a slightly roughened area was found three to four inches above it in the external iliac vein, this was the probable attachment of the thrombus, which had proved fatal He had apparently a segmental phlebo thrombosis of the external iliac vein on the side of the operation, although the veins of the other limb were not examined

Myers and Lowell (1954) also report one fatality after stripping of varicose veins, his incidence is 1 in 2,660 of such procedures, equalling 0 037 per cent

AFTER-CARE

The groin wound.—After the stitches have been taken out, no dressing is required, all it needs is cleansing morning and evening with surgical spirit, until it is obviously stable If it is moist, painting it twice a day with Tr benzoin co is useful

The danger of anti-biotic and sulpha-drug applications.—A caution is necessary regarding daily dressings with penicillin, anti-biotic or sulphonil-amide ointments and creams They have become "usual" local remedies nowadays and are, in our experience, ineffective and actually harmful, for many patients are sensitive to them and tiresome rashes may appear locally and elsewhere, which give considerable anxiety and difficulty before they subside These substances are unnecessary locally in any condition concerned with varicose veins, *e g* wounds after operation, ulceration or eczema of the leg

Zinc oxide and rubber plasters.—Any adhesive strapping containing rubber and zinc, *e g* Elastoplast, Flexoplast, Dalzoflex, is prohibited on the skin, because of frequent sensitivity reactions, which cause patients considerable inconvenience and may take several weeks to subside

Elastic stockings.—A well-fitting elastic stocking is a warm compressive and mechanically protective garment Its pressure resists the tendency of a limb to swell and assists the restoration of normal size, shape and function

Stretching of the skin by swelling renders it more liable to breakdown and ooze when knocked or scratched during the daily round

Men wear the stockings to the knee, and women to the mid-thigh. Shorter types of elastic garments for the lower leg or ankle are available for the scarred ulcer area These are suitable in hot weather

Elastic hose are worn for three to twelve months after operation for varicose veins or ulceration according to the state of the limb Where the ulcer was of long standing (it may have existed twenty years before effective treatment was instituted) and an area of scarred, thin pigmented skin remains, the pressure support may be required for years, possibly for the remainder of the person s life, especially after a post phlebitic ulcer and in those over 50 years old

For those with the erythro-cyanotic tendency protection from cold in the winter is essential or superficial necrosis readily appears a thick elastic stocking is beneficial

Elastic stockings are available in various textures Some are made with cotton or nylon covered rubber threads and others without rubber the latter are valuable for the persons who are allergic to rubber close to the skin

Closely woven and thick stockings are suitable during working hours and in the winter as they combine pressure, warmth and mechanical protection which are essential for the leg that swells, has been ulcerated or is prone to chilblains Other such garments made with a cellular mesh are lighter cooler and of pleasing appearance they are acceptable in the summer and for social occasions but are not so effective for compression During unusual activities, such as a period of standing or when the skin has become swollen or inflamed a tight bandage may be applied over the stocking. Those with " leg " trouble must be warned of the danger of allowing their legs to swell for this is the beginning of the slippery slope to pain itching eczema and ulceration



FIG. 213
Protection of the lower leg after ulceration by trousers and an anklet of diachylon strapping, later by an elastic stocking.

Trousers—In women wearing trousers, in addition to elastic stockings whilst performing their heavier duties is *invaluable* (Fig. 213) although the former is a tendency we men deplore The thick material " cushions " the legs from small traumatising incidents which pass unnoticed in normal limbs, but which may start an ulcer or eczema in those with venous disorders (superficial and deep) or previous ulceration (Fig. 213) *Trousers also conceal* bandages and unshapely legs.

Exercise.—The development and maintenance of good leg muscles is invaluable in assisting the venous return, especially in those with incompetent deep veins The exercise discourages venous stasis and thrombosis and helps to keep the weight down Patients are urged to take a daily walk of one to two miles for the rest of their lives and to renew their former recreations such as dancing, cycling, table-tennis, golf, etc Raising the legs off the bed six to ten times, and " pedalling-in-the-air " before getting up also improves the muscle power and tone

Standing, sitting and kneeling.—Patients are warned not to stand for long periods, especially when it involves lifting and straining, as in ironing and carpentry Raising the feet to or above the horizontal position when sitting is helpful Patients may sit or kneel at work and should avoid standing, but if this is essential, then the value of marking-time or an occasional walk is explained

Air travel and long sitting.—Those with venous disorders of the lower limb and who take long journeys by air find that their feet, ankles and legs swell to a painful degree The remedy is simple Elastic stockings or pressure bandages are worn and the shoes are kept on Twenty to thirty deep breaths are taken every hour The feet are actively flexed and extended frequently. The passenger deliberately stands hourly and visits the toilet rather oftener than is necessary for the walk, with deep breathing and leg exercises, such as marking time

These precautions avoid being unable to put on the shoes because of excessive swelling at the end of a night flight

Stiff joints ; flat feet.—Many legs and feet with venous disorders become stiff in malpositions, *e g* equinus and pes planus After the operation and healing, these are massaged, manipulated and re-educated to improve and restore muscle function Flat feet of varying degrees are common with varicosities and ulceration of the leg These may require mobilisation by manipulation Manipulation of the foot takes five seconds, no anaesthetic being needed , it is done at the follow-up visits The foot is forcibly everted and inverted , it causes momentary acute pain and it gives immediate complete or considerable relief Robust shoes, suitably corrected with wedges (if necessary) are worn from the moment of getting up until going to bed. Patients are asked not to wear slippers The conventional female shoe with its pointed toe, thin sole, and raised heel does not give these enlarged, deformed feet comfort or support Further, high heels put the calf muscles on the slack which predisposes to stagnation and thrombosis in the muscle veins Figure 214, showing that the outline of the foot is outside that of the shoe, was drawn from life , it can always be reproduced in the hospital out-patients and the consulting room A bespoke shoe is a solution, but with the shortage of shoemakers and the high cost, this is not always possible If

a woman can be persuaded to wear a boy s or youth s shoes, much comfort will be gained as they provide the width at the toes and robustness the heels can be raised somewhat to suit the feminine taste The lowish ' heel exercises the calf-muscle pump and improves venous drainage. A remark repeatedly heard from women who have tried them is "I had no idea that shoes could be so comfortable."

Equinus deformity—In long-established ulceration an equinus deformity often develops, but is usually temporary and disappears when epithelialisation is complete. It may persist when the ulcer is healed and requires a long period of physiotherapy Lengthening of the tendo-Achillis may be necessary to restore normal walking in flat heeled shoes. It is essential to give patients a functioning calf-muscle pump

Physiotherapy—This is invaluable in assisting ulcerated legs to acquire greater joint movement and easier walking. Given cautiously after healing, it will assist in mobilising a scar and improving the skin in preparation for the division of faulty ankle perforating veins. This deep massage is associated with the name of Bisgaard (1948)

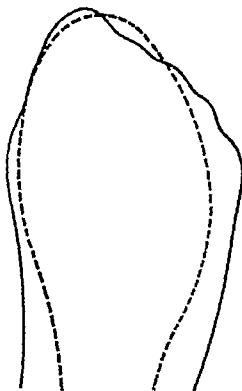


FIG. 214
The outline of a foot contrasted with that of the shoe the patient was wearing.

Chiropody.—The chiropodist gives treatment when necessary it is a great help to comfortable walking, particularly for older people

Obesity.—Subjects with varicose veins and their complications often become obese and infirm from the continuous resting erroneously prescribe by many medical and lay advisers Their activity is of necessity limited Women form the majority of sufferers. The difference between the health woman s weight of 112 150 lb (50 70 kilos) or 130 180 lb (average man weight) and 170 250 lb., which is frequent in those with "bad" legs, need only to be mentioned to be apparent. To derive the maximum relief this bulk must be reduced.

Obesity causes slow and unsteady movements and early fatigue It impairs the balance The fat of the buttocks and thighs sways during walking and predisposes to falling. Flat, painful feet strained internal lateral ligaments of the knees and premature arthritis follow Stoutness may b associated with hormonal insufficiency but often it follows excessive eatin prolonged rest to obtain relief from pain and healing, and lack of exerci

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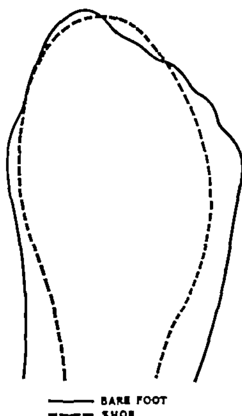


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Weight reduction.—This problem requires collaboration with an endocrinologist and a physician, but the following points often effect considerable reductions in weight.

The defective veins and ulcer are dealt with ; this permits the resumption of activity The after-care already described is implemented

1 *The general health* is remedied as far as possible, especially anaemia

2 *Discomfort.* Pain is relieved by sedatives, physiotherapy and exercises

3 *The diet* is adjusted Patients are advised to eat and drink only as much as they need ; all fats and fried foods, especially roast and mashed potatoes, are forbidden, as are butter, pastries, biscuits, chocolates and sweets Patients often co-operate enthusiastically when foods are limited but not forbidden Fresh fruit, vegetables, boiled or baked potatoes are permitted Wholemeal bread is advised in moderation Salt is avoided, as it encourages water retention , pepper is a satisfactory substitute Patients may partake reasonably of lean meat, fish, rabbit, chicken, ordinary cheese, boiled or poached eggs, cooked without fat

4 *Supervision* Encouragement is given, a weight chart being kept and regularly inspected The progress and well-being restores the patient's hope for their participation in full work and social life, which they feared was gone New legs cannot be given, but bad legs can be greatly improved by treatment and instruction The policy followed is " care " and " use," not " rest "

5 *Medicine* Thyroid gr 1 - 3 combined with small doses of oestrogen (stilboestrol or dienoestrol 0 5 mg to 1 mg) daily may give an appreciable reduction of weight in a proportion of women, especially those at and after the menopause

Spa treatment is useful for those who can obtain it, especially in mobilising joints It assists patients' morale and efforts.

Follow-up care.—After an operation for varicose veins and its allied conditions, irrespective of the treatment given, the legs are periodically inspected for three to five years The amount of after-care depends on the extent of the venous disorder and its complications when relief was sought Early cases require little or no subsequent treatment ; established cases will need more care The former only need to be seen annually, but the others perhaps monthly for six months and then the intervals lengthen In this way, no condition can relapse seriously without being seen

THE RESULTS

The results of varicose vein operations depend on a correct diagnosis, a complete operation and after-care The degree of their development when treatment is begun qualifies the result from the point of view of time. We believe that five years is the necessary period of follow-up for the assessment of surgical procedures for varicose veins

We have not yet a five-year period after the stripping operation but below we sketch the effect of the procedure of terminal saphenous ligation internal abrasion of the saphenous trunk and several small sclerosant injections, which preceded stripping in the practice of one of our team It gave 90 per cent of satisfactory results. Although we have only been stripping for four years we are satisfied that this is the best procedure for varicose veins Patients need fewer post-operative injections, are quickly back at work and have less post-operative discomfort.

We give the following review of 275 patients in order to show that something can be given surgically for gross varicose veins

These were treated by saphenous ligation internal abrasion and sclerosing injections whilst sixty-one other patients were treated by terminal ligation and only the injection of sclerosant distributed along the saphenous trunk

Of the limbs operated upon 90 per cent. had an incompetent internal saphenous vein and 10 per cent. an incompetent external saphenous vein

In analysing the results of ligation abrasion and injection standards had to be set which were quite arbitrary An excellent result was recorded when after the initial operative procedure follow-up injections were only necessary at infrequent intervals and the legs looked and felt well to the patient and surgeon A "good" result indicated that injections at more frequent intervals (*i e* three to six months) were necessary to render the legs in trim " "satisfactory" that the condition was controlled by a great deal of after-care and "not satisfactory" that recurrence of varices and recurrence of ulceration or eczema had occurred

These terms are really a reflection of the extent of the varices when the patient sought treatment, and how the examining surgeon felt about the appearance of the legs at the follow-up inspection they are a clinical standard rather than a measured one Thus, a good " or excellent " would be given readily to slight varicose veins and a mere "satisfactory to the result of gross varicose veins complicated by oedema eczema ulcer or obesity which needed further follow-up treatment. Since, however on the whole more severe cases attend a varicose vein clinic than mild ones, a good overall picture of the effect of a treatment may be obtained and give useful guidance The groups "excellent," "good," and "satisfactory" have been combined under the heading satisfactory"

All patients with oedema eczema or ulceration received Diachylon or similar pressure bandaging all were treated by the ambulatory method

A striking feature was the high standard of health and ability to follow their regular employment after the initial operation and regular out patient care.

Of the 275 patients who received abrasion with a rough-headed needle at operation and injection with phenol-glycerine solution quinine or lithocaine 89 8 per cent. were classed as satisfactory compared with 82 per cent of 61

patients who were not abraded at operation These patients were followed up for three to six years

Of the patients in the phenol-glycerine group, only 26 (9 9 per cent) were classed as unsatisfactory, and the majority of these broke down because of an incomplete diagnosis in the first place The patient's own comment of " beautiful," " fine " or " wonderful " on the appearance of his or her legs was frequently recorded Even those with unhealed ulcers or eczema were satisfied and grateful, because they were comfortable and able to do their work

Results after stripping operations.—Bolton Carter (1954) and Myers (1954 and 1955) report good results after stripping of varicose veins

Myers' series consisted of 1,189 strippings on the internal saphenous veins and 109 on the short saphenous vein, whilst 210 of them had had previous operations for their varices He had but two per cent of recurrences after stripping of the internal saphenous vein and none after treatment of the external saphenous vein stripping He had ninety-two per cent of good or excellent results from complete strippings of the internal and external saphenous veins after an average follow-up period of thirty months The same good results were obtained in patients who had had deep venous insufficiency and varicose veins The follow-ups were not so good with stripping only to the knee, about eighty per cent good, and there were 12 1 per cent of recurrences His findings have led him to adopt the most thorough eradication of the varicose systems, " even if the veins must be removed by direct dissection or by undermining and evulsion through multiple incisions Incompetent perforating veins wherever found, but most frequently found from the knee to the foot, especially those below the knee, must be carefully ligated to guarantee a good lasting result " We agree with this

REFERENCES

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CHAPTER X

PERSISTENT OR RECURRENT VARICOSE VEINS

INTRODUCTION

OPERATIONS on legs with varicose veins eczema, ulceration and swelling are becoming increasingly frequent and may be the commonest procedure of many general surgeons. When adequately done with



FIG. 215
Persistent varices after stripping of the internal saphenous vein, due to over looked varicosity of the external saphenous vein.

good after-care, they score brilliant successes or considerable improvements but recurrences or re-appearance of varices are all too frequent On the average we see one or two per week. In a series of nearly 1 000 operations for varicose veins and their complications there were 110 which were done for

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the second or third time One was a surgeon and two were dental surgeons, who, because of their persistent varicosities, were unable to stand through their operating sessions

As it is only since 1945 that the criteria for complete treatment have emerged and these have still to become widely known and accepted, this

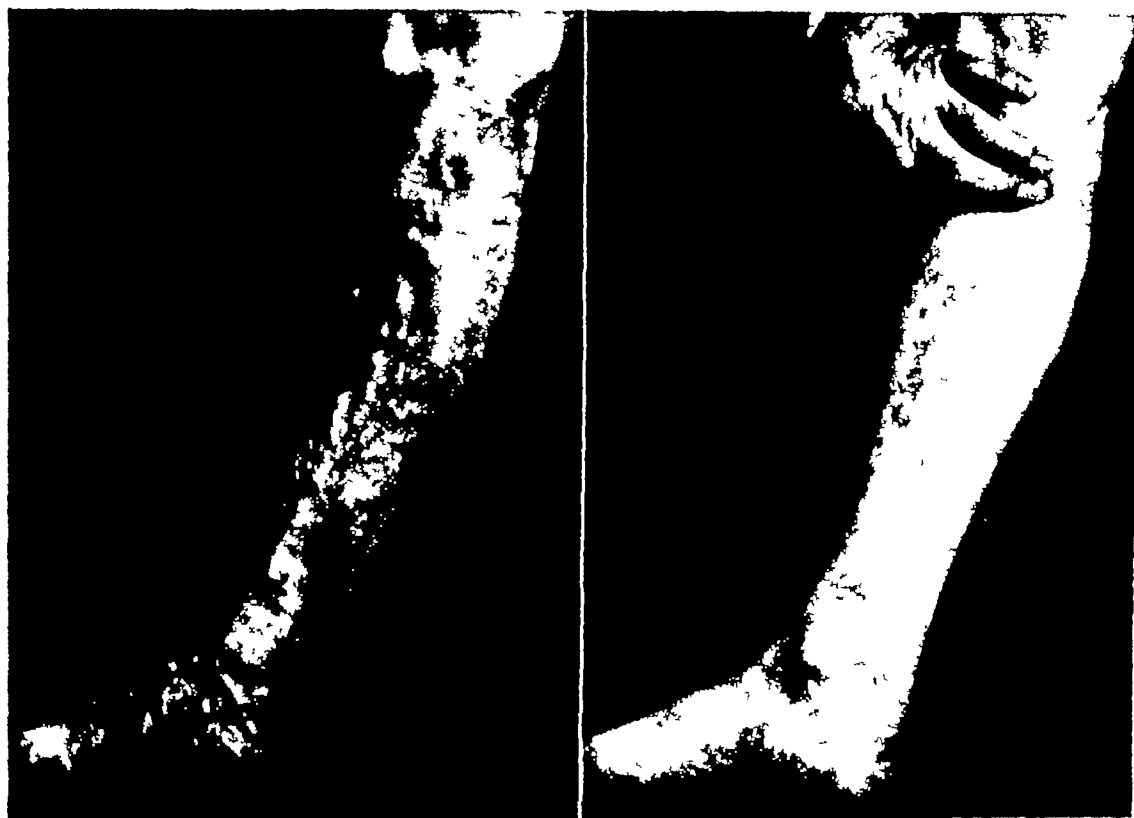


FIG 216

A recurrent varicose anterior vein of leg after stripping of the internal saphenous vein two years before due to an *undiagnosed incompetent perforating vein* at the posterior border of the internal tibial condyle, note that pressure with a finger controls the varices

recurrence rate is understandable. Follow-up results are becoming available Foote (1954), Fratkin and Jackes (1951), Bolton Carter (1954), Myers (1954 and 1955), and these indicate the effectiveness of surgical measures.

The causes.—The persistence or recurrence of varicose veins and their complications after operation are caused largely by one or more of the following:—

1. Inadequate diagnosis
2. Inadequate operation
3. Inadequate after-care
4. New varices
5. Non-co-operation of the patient

INADEQUATE DIAGNOSIS

One of our team has been operating on varicose veins since 1926 and many patients have been followed-up Persistence or recurrence of varices in some cases has been due to a partial or wrong diagnosis. Examples are those of diagnosing an internal saphenous vein varicosity when the external saphenous is varicose and vice versa also when both saphenous systems are defective only one is detected and treated (Fig. 215) An incompetent communicating



FIG. 217

Recurrent varicose veins due to incompetence of the *communicating vein passing into* Hunter's canal. Note (*a*) the incision for the first sapheno-femoral "tie" was too low (*b*) the veins appeared in the calf with a high tourniquet (*c*) the varices were controlled by the band at the lower third of the thigh below the entry of the perforating vein into Hunter's canal.

vein or veins may be present and not noticed the varices being secondary to deep venous insufficiency (Figs 216 217 and 218) An impacted pelvic tumour (Fig. 69) although admittedly rare may also contribute to the maintenance of an unduly high intravenous pressure in the thigh tributaries of the internal iliac vein The rare congenital or traumatic arterio-



Fig. 218

Recurrent varicosities and ulceration due to *incompetent ankle perforating veins* (previous excision of prominent varices (1923) and sapheno femoral ligation (1949))

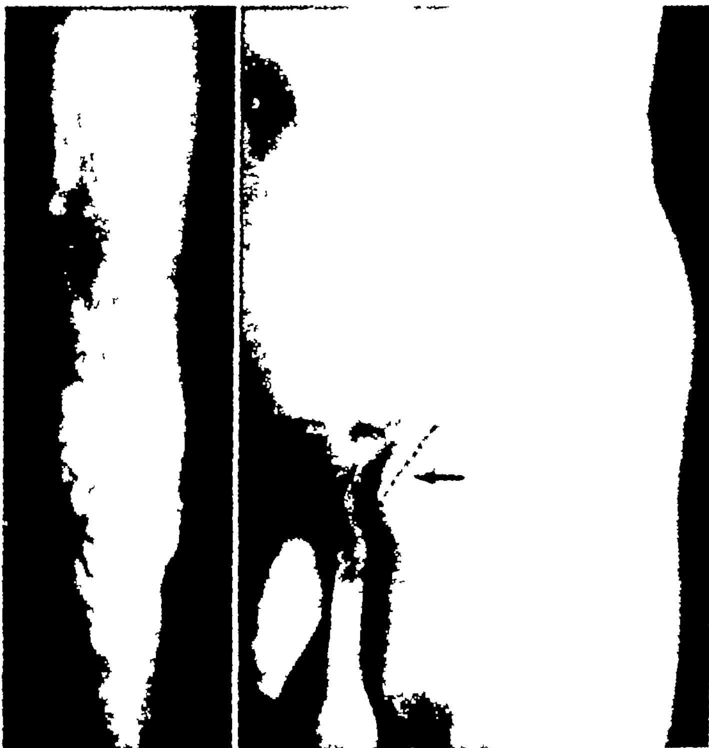


Fig. 219

Recurrent internal saphenous veins with a saphena varix due to failure to ligate the internal saphenous vein. The first incision is inked in, a considerable varix underlies it

venous fistula or fistulae *if undetected and untreated* will maintain varicose veins no matter what is done to the veins

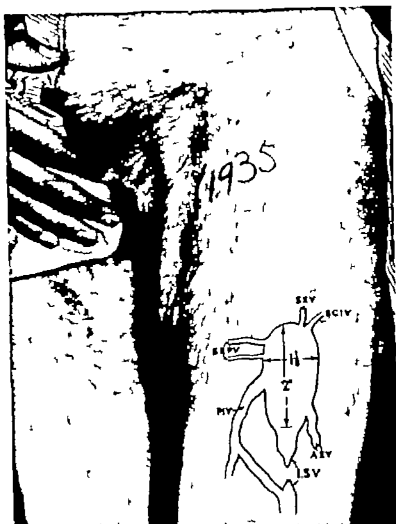


FIG. 220

A recurrent internal saphenous varicosity due to an inaccurately placed longitudinal incision (shown by the line) The internal saphenous was tied too low The curious longitudinal fold to the inner side of the incision is a huge saphena varix 1½ inches diameter by 2 inches long the largest that one of us had seen. The inset shows the findings at the second operation I.S.V = internal saphenous vein P I V = postero-internal vein S.E.P V = superficial external pudic vein (duplicated) S.E.V = superficial epigastric vein S.C.I.V = superficial circumflex iliac vein A.E.V = antero-external vein.

INADEQUATE OPERATION

The following have been found to be the main causes of recurrent superficial varicose veins

1 **Failure to ligate the internal or external saphenous trunk.**—Odd as this may seem it is frequent a large tributary is ligated instead (Fig 219)

2 **Non-terminal saphenous ligation** (Figs 220 and 221) —If, at the original operation, the ligation of the long or short saphenous veins was not at their ending and flush with femoral or popliteal veins so that one or more of their tributaries remained undivided between this tie and the sapheno-femoral or

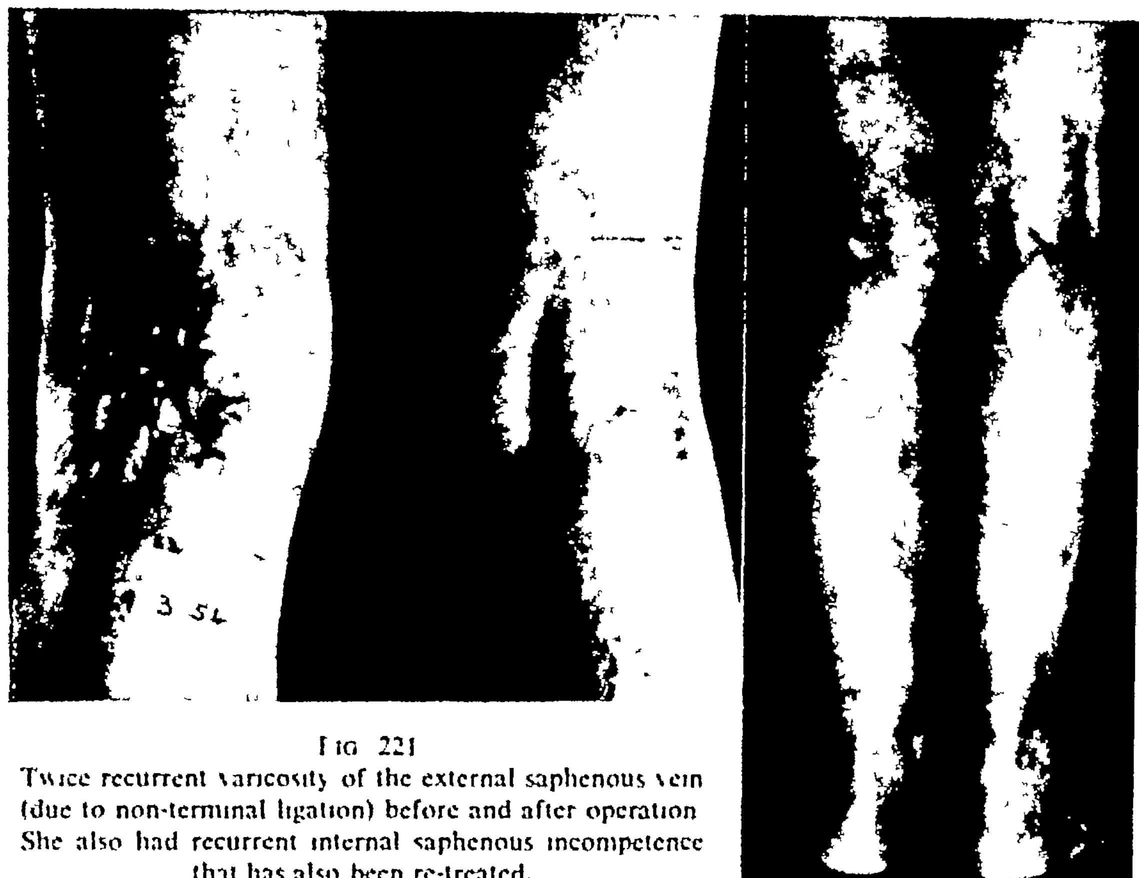


Fig 221
Twice recurrent varicosity of the external saphenous vein (due to non-terminal ligation) before and after operation She also had recurrent internal saphenous incompetence that has also been re-treated.

sapheno-popliteal junction respectively, then the high intravenous pressure in the femoral or popliteal veins continues to pass into these uninterrupted tributaries Such vessels progressively dilate and by diverse anastomotic channels ultimately connect up with the trunk of the internal or the short saphenous vein and their radicals distal to the ligature and fill them with blood under high pressure Some of these vessels would be already varicose or in due course would become so from the hypertension to which they were subject. This re-appearance of varices with symptoms demanding attention usually takes one to five years. The omission to ligate all the saphenous tributaries is almost inevitable when the internal or external saphenous vein is divided at varying distances below the actual junction with the parent vein, and the more distal it is the more tributaries will remain, and by-passing of the point of section with restoration of the back-pressure into the saphenous trunk and its area of drainage is assured The fault lies in the surgeon's failure to expose the sapheno femoral or sapheno-popliteal junction and to see a portion of the

deep vein (*i.e* femoral or popliteal) above and below the union before placing the critical ligatures. From personal experience we can vouch that this requires

(*a*) Familiarity with the basic venous anatomy

(*b*) A correctly placed and large incision



FIG. 222

A—Recurrent varicose posterior arch vein, secondary to two previous imperfect terminal internal saphenous "ties." The appearance of this lower leg is highly suggestive of an incompetent ankle perforating vein but the tests were negative. The small arrow in the lower third of the thigh indicates a "blow-out," and the irregular line above and below the knee, the palpable internal saphenous trunk B—The patient is well after a saphenofemoral ligation and stripping of the internal saphenous trunk in February 1954 he was last seen in December 1955. The incisions were inked over with ink before the photograph.)

Unligated tributaries.—The omission to divide all the tributaries at the termination of the long saphena or short saphena merits emphasis as causing the re-appearance of the varices (Figs 222 and 223) This factor is an effect of the preceding one of a "low" division of the internal or external saphenous veins. In three of our patients with recurrent internal saphenous varices because of the failure to tie the superficial epigastric vein (twice) varicosity of the internal saphenous vein and its tributaries with an impulse on coughing

FIG. 223

A doctor's legs with twice recurrent left external saphenous varicosity and right internal saphenous incompetence The former was due to a non terminal short saphenous tie



Recurrent right inte[illegible]
causing eczema of the [illegible]
Both were due to non [illegible]
in[illegible]



[illegible]

A

B

C

Fig. 2-5

A, B—Recurrent varicose veins twenty-six months after bilateral sapheno-femoral ligation and stripping, due to undiagnosed faulty communicating veins in the thigh and above the ankle. C—Ligature of the incompetent communicating vein in thigh (indicated by the director).

and a positive tourniquet test recurred in two to three years. Numerous other similar persons have been treated In such cases, even if follow-up sclerosing injections were given, the reappearance of varices could not have been prevented, because no thrombosis can withstand the pressure and activity of venous hypertension The large incision already detailed goes far to avoid this error (Chap VIII)

Stripping and retrograde injection of a sclerosant.—*Basically, stripping, sclerosing injections, or internal abrasion and sclerosing injections are but useful adjuncts to the strategic ligation of the incompetent connections.* They are not curative, and if defective veins remain to transmit high intravenous pressure outwards, the long or short saphenous vein recanalises (unless stripped) as tough, fibrous vessels that may not allow the complete passage of the stripper at the re-operation (Fig 224) Numerous such repeat operations have now been done

Recurrent varices after stripping.—One of us has seen three patients with recurrent varices after stripping of the internal saphenous vein All were in the internal saphenous territory and were due to undiagnosed incompetent communicating veins, two were passing into Hunter's canal (Fig 225), the other recurrence was from the perforating vein that penetrates the deep fascia, immediately behind the internal condyle of the tibia below the knee (Fig 216).

Ligation of these cleared the varices

It is stressed that stripping is as liable to recurrences as any other method of treating varices Stripping only removes the saphenous trunk and leaves its tributaries available for dilatation if a source of high venous hypertension remains connected with them (Fig 190)

Thus the surgeon is confronted with the necessity for a complete diagnosis and an effective operation

We have met surgeons who had the impression that when they stripped the saphenous trunk they also tore it from the ends of communicating veins which then sealed off by thrombosis and organisation thereby neutralising the danger from incompetent perforating veins and making the need to diagnose them unnecessary Whilst the communicating veins do occasionally connect directly with the saphenous trunk, they are more frequently linked indirectly through small tributaries which remain after stripping and will convey the venous hypertension to the veins in their area and in time render them varicose

Recurrent internal saphenous varices.—The following items have been observed in patients with recurrent internal saphenous varices :—

1. THE INCISION

(*a*) *Its length*—The incision used at the first operation for the sapheno-femoral ligation has varied widely, it has frequently seemed to us to be too

short to give an adequate exposure being one to two inches long (Fig 226A) For consistent success we have found it is better to make it longer than necessary at least four to five inches, so that the sapheno-femoral union and the internal saphenous vein in its upper third *i.e* 4 5 inches (10 13 cm.) can be displayed this will locate the postero-internal tributary wherever it joins (Fig. 226B) Occasionally the antero-external vein unites three to five inches below the sapheno-femoral junction instead of usually at the end

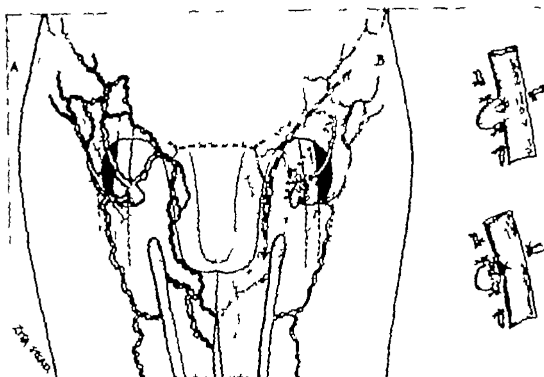


FIG. 226

The right side (A) shows the average finding in a case of recurrent veins after a low internal saphenous ligation note the short incision placed too low The left side (B) shows (1) the large high incision for recurrent long saphenous varices in contrast to the usual incision for sapheno-femoral ligation (dotted-in) and (2) the ligation of tributaries and the double tie at the sapheno-femoral level.

(*b*) *The position of the incision*—Almost invariably the incision has been too low to give access to the termination of the saphena magna it was variously one to four inches below the fold of the groin Frequently it was so medial or lateral to the sapheno-femoral union as to render its ligation almost impossible only a tributary could be tied through it. *Whatever incision is used be it hockey stick oblique or vertical its* centre *must lie over the sapheno-femoral junction which is* 1 1½ *inches outside of and below the pubic tubercle it should be measured in each patient*

2. THE TRIBUTARIES

The deep external pudic and postero-internal veins—In connection with overlooked tributaries, the surgeon must be aware of the occasional presence

inside of the foramen ovale of the deep external pudic veins (forty per cent) and of the postero-internal tributary They occasionally join, but may be separate As these veins unite at the inner and slightly inferior aspect of the sapheno-femoral union, they are easily missed, and the main ligature will be placed below them, and varices will recur in the inner and posterior thigh and perhaps in the calf (Fig 175) Less often the postero-internal vein joins the femoral vein directly half an inch to one inch below the saphenous confluence, where again it can be overlooked unless the lower edge of the foramen ovale is divided

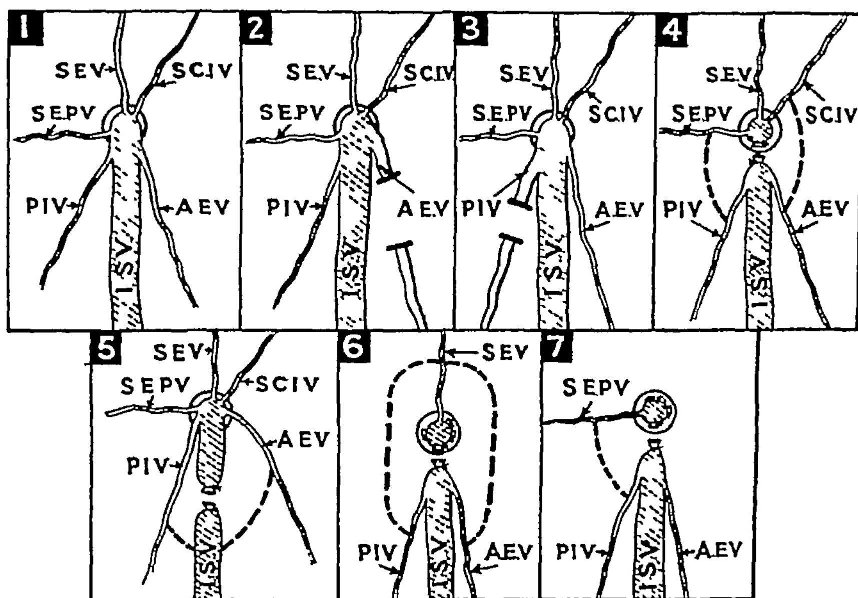


FIG 227

Types of imperfect "terminal" internal saphenous vein ligation

1—The normal terminal anatomy of the great saphenous vein 2—The antero-external vein is mistaken for the internal saphenous vein 3—The postero-internal vein is tied instead of the long saphenous vein 4—The internal saphenous vein is almost terminally ligated, but not all its tributaries 5—A "low" division of the internal saphenous vein, all the tributaries are intact 6—Another type of so-called "flush" tie, with the superficial epigastric vein untied 7—A "top" tie, except that the superficial (or deep) external pudic vein remains undivided

Other internal saphenous tributaries (Fig 227) —The other four terminal saphenous tributaries must be found and divided to the satisfaction of a critical assistant, just as in biliary tract operations the cystic, common bile and hepatic ducts are displayed before cholecystectomy is performed

Since the practice of naming each tributary individually has been adopted, it is rare to find one absent, although their combinations are bizarre At our numerous procedures for recurrent internal saphenous varices, all the radicals have been found undivided at one time or another The insistence on the ligation of the internal saphenous vein precisely at its union with the femoral vein is because this ensures that all the tributaries are divided and disconnected from the high pressure of the deep veins

In rare instances one of the tributaries of the internal saphenous vein from the lower abdominal wall may join the femoral vein direct, above the sapheno-femoral union If the femoral valve immediately below the Poupart's ligament is sound this abnormal arrangement would not be surgically significant but as this valve is defective in over thirty-six per cent of patients then the high and varying thoraco-abdominal pressures can pass into these superficial veins and the varices ultimately re-distend and extend Thus it is advisable to see the common femoral vein for half an inch above and below the sapheno-femoral union.

Failure to ligate the internal saphenous vein.—This has been found on many occasions possibly its postero-internal (the accessory saphenous) vein or its antero-external tributaries were mistaken for it and divided instead (Fig 227 2 and 3) Variations of the long saphena may have been present but these are very rare in our experience and they could not have been recognised through the small incision generally made The internal saphenous vein may have been ligated in continuity with catgut, which being absorbable allowed the vessel to recanalise

In 1939 one of us tied a tributary of the internal saphenous vein in the belief that it was the main trunk in 1951 the patient reported with pain swelling and gross varicosis On re-operation the internal saphenous vein was found intact

In 1954 one of us operated on thirty three patients with recurrent internal saphenous varicosities two were twice recurrent. They were divided —

1 Internal saphenous vein unligated (Figs 219 and 222)	7
2 "Low" ligation of internal saphenous vein with by-passing through the tributaries and a mass of varices (Fig. 227 4 7)	24
3 Undiagnosed communicating vein in the thigh (Fig 225)	1
4 Multiple ligation	1
5 Associated with incompetent ankle communicating veins	10

The symptoms the recurrences caused were —

Swelling of the ankle	2
Eczema	5
Ulceration	7
Varicose veins	19

The recurrent varicose external saphenous vein.—It is uncommon for patients to be seen with recurrent or persistent varices after an operation on the short saphenous vein as varicosity of this vein is comparatively rare being only one-tenth as frequent as the internal saphenous vein It is commoner to see patients where varicosity of the external saphenous vein has been overlooked after treatment of the internal saphenous vein (Fig. 215) One of us has operated on eleven patients with recurrent short saphenous varices, five being in 1954 two of whom were twice recurrent (Fig. 223)

In recurrent varices of the small saphenous vein, the errors have been:

1 An inadequate incision.
2 Low ligation of the external saphenous vein
3. Failure to ligate the external saphenous vein

1. **The incision.**—This is mentioned first because from it the next features of a low tie of the external saphenous vein or failure to ligate it, to a large extent derive In nine of the eleven cases one of us has done, it was too short and incorrectly sited Often it was but one inch long either longitudinally or transversely and was close above or below the knee-joint line (Fig 223). We cannot resist the conclusion that these surgeons were unaware of the basic anatomy of this vein and the same applies to the recurrent internal saphenous veins we have done Readers are urged to refer to Chapters III and VIII regarding these fundamentals We find it necessary to assess every patient individually and to map out the landmarks, although our operations for these procedures now extend into four figures The sapheno-popliteal junction may be from 1½ inches below the knee-joint line to 4½ inches above, which shows the need to select the incision, the longitudinal extensions of a transverse incision give mastery of this area and should be made unhesitatingly (Fig 194)

2. **Low-level "tie".**—In seven of our recurrent cases, a considerable stump of the external saphenous vein remained with undivided varicose tributaries between the point of division and the sapheno-popliteal junction (Fig 221) On the whole, we would say that the sapheno-popliteal union occurs more frequently at the extreme upper end of the popliteal space than at its centre or lower parts Thus an accurate estimation of this is necessary as well as a suitable incision The external saphenous vein occasionally runs alongside of the popliteal vein for one to two inches before finally uniting with it In two of our series, an attempt to make a sapheno-popliteal ligation had been made twice before, but a stump of the external saphenous vein at least one inch long was found with an intact tributary The usual varicocele-like mass of veins obscured the stump and made the procedure tedious and exacting In such cases the longitudinal extension of the transverse or S incision is essential (Fig 194)

3 ***Failure to ligate the external saphenous vein.***—One of us has made this error twice and we have seen it in two other patients It is difficult to explain why, possibly a long communicating vein was mistaken for the external saphenous vein It lays emphasis on the value of a stripper or ureteric catheter inserted into the vein first from the ankle and also on the need to see at least one inch of the popliteal vein A venogram is invaluable. for an inefficient long oblique communicating vein passing from the middle of the calf to the popliteal vein may be revealed and this can mimic varicosity of the small saphenous vein

The excision of superficial varices.—Numerous patients have been re-operated on who have had the older procedure of excision of clusters or sections of prominent subcuticular veins (Fig. 228) Such operations could never be successful no matter how painstaking the surgeon. The extensive removals from the groin to the ankle through numerous incisions failed because the main saphenous trunk with its deep connections often remained



Fig. 228
Recurrent varicose veins after a wide excision of the superficial vessels. (T = Thrill felt. C I = Cough impulse present.) The varices visible are not the varicose trunk of the internal saphenous vein but some of its varicose tributaries.

untouched on the deep fascia and therefore, the high intravenous pressure passed into it from the unligated sapheno-femoral junction or other incompetent perforating vessels and time rendered further superficial veins varicose One man, by the excision of prominent clusters, was relieved and enabled to win a naval boxing championship for several seasons but he reported with recurrence of the veins discomfort and oedema of the leg thirty years later

Multiple ligations.—Several patients treated by multiple ligations have been re-operated on for recurrent varicose veins; there has been the "usual" overlooked tributary at the foramen ovale, and the saphenous trunk, in spite of a procedure designed to divide it, has been found repeatedly intact At the operation, after the flush sapheno-femoral tie, the saphenous trunk has been stripped out without difficulty, showing that these multiple saphenous ligations can fail to locate the saphenous trunk as it lies obscurely on the deep fascia, especially in the obese limb. In any case, this method of multiple ligatures cannot neutralise inefficient communicating veins, which by diverse anastomatic channels refill the ligated sections and their varicose tributaries

Internal iliac vein incompetence.—A rarer source of filling is that from incompetent parietal tributaries of the internal iliac vein in the posterior thigh the chief being the inferior gluteal, sciatic, obturator and pudendal The pelvis is examined, if necessary by a gynaecologist under an anaesthetic, to exclude the possibility of obstruction of the internal, external or common iliac veins by inflammatory masses or tumours Ligation is seldom necessary, but should the tourniquet or thumb pressure over a suspected vessel indicate inefficiency in it, then its ligation is unhesitatingly carried out Sclerosing injections and a pressure bandage for two weeks may be adequate for these varices

Inadequate after-care.—Some patients have received efficient ligation and treatment of the saphenous trunks but if their subcuticular varices are untreated afterwards they gradually fill, become prominent and cause symptoms The re-filling can be from normal veins, faulty communicating veins (present or future), a defect (present or future) in the other saphenous system, or from the rare arterio-venous fistula. Thus there is the need to retest persistent or re-appearing varices with tourniquets, etc, to determine the actual site of the filling source

Non-co-operation of the patient.—It is exceptional for patients not to co-operate in their after-care if the necessity is explained There is a small proportion who do not return for reasons of home and work requirements, changed residence, and sometimes because their immediate need is relieved by the operation

Recurrent varicose veins of uncertain diagnosis.—When the attempt to diagnose the source of filling of recurrent varices fails, because the results of the tests are conflicting, a venogram is resorted to (Chap XIII). There may be no gross incompetence of the internal or external saphenous veins, although the latter is readily overlooked Possibly a faulty communicating vein or veins are present above the ankle or in the calf associated with some deep venous incompetence or rarely a small arterio-venous fistula When such vessels are located, they are dissected out and divided (Chap XVII)

Failing a clear-cut finding, if swelling and discomfort are present, elastic stockings or compression bandages are worn and sclerosing injections are given say monthly into the prominent varices until they are thrombosed. A fair number may be required, but often they are effective and the periodic inspection and testing is continued. A diagnosis may become apparent later as the condition develops. The inefficient vessel may be found to lie under or immediately above the skin eruption or ulcer and it is then divided.

Reasons for re-operation.—These are mainly due to the re-appearance of the symptoms and signs for which the operation was initially performed especially re-ulceration, eczema, swelling, pain, thrombophlebitis and the unsightliness of the varices.

THE TREATMENT OF RECURRENT OR PERSISTENT VARICOSE VEINS

Patients with persistent or recurrent superficial varicose veins are dealt with as are those who have not been treated previously.

History and diagnosis.—The history is taken, a systematic clinical examination is made (including the abdomen whilst the patient is standing and lying down). A diagnosis is built up by inspection, by palpation (percussion) of the large varices in the erect and in the supine position with the leg raised. The terminations of the internal and external saphenous veins are particularly examined.

The cough impulse test is made over the prominent veins in the thigh (not over the foramen ovale) and leg; if an impulse or thrill is felt, this is proof positive of saphenous vein inefficiency and the need for re-operation. The venous collapse and filling tests with the tourniquets are elicited; these are more sensitive than the cough impulses. The percussion test gives good supplementary evidence.

Marked warmth of the skin overlying varices or a bruit in the veins on auscultation would raise the possibility of an arterio-venous fistula, which is an unusual but possible condition (King, 1950, and Piulachs and Vidal-Barraquer, 1953).

The abdomen and rectum is examined for tumours. The abdominal wall is scanned for enlarged varices, which would indicate previous deep vein obstruction which is usually followed by communicating vein inefficiency above the ankle. These factors have already been mentioned but they are often overlooked before the first operation (Chap. XIV).

The state of the deep veins is elicited, including phlebography in cases of doubt (*see* Chapter XIII).

From the diagnosis the requisite treatment is planned. Most of the recurrences are in the internal saphenous system and in the communicating veins in the lower leg.

The treatment.—This consists of injections or operation

Injections.—In those instances where no frank saphenous or communicating vein incompetence is present, a series of sclerosing injections will clear the varices, supplemented possibly by elastic stockings

Operation.—A further operation is needed where saphenous or perforating vein incompetence is present The excision of a mass of thin-walled tortuous varicose veins through which the retrograde venous flow has been restored, from the groin or popliteal space, may be required , it is tedious and difficult The haemorrhage is often copious, but operating in the Trendelenburg position is valuable in reducing it Attempts to control bleeding from the thin-walled fragile varices, even by applying light-weight haemostats, may aggravate it by their tearing off , the veins are managed best by ligation with an aneurysm needle, or by immediately under-running them with a fine stitch on a small round-bodied needle

Recurrent internal saphenous varicosities.—The findings at the second or even third operation vary as has already been described.

Operative procedure.—The aim of the operation is to ligate the sapheno-femoral junction flush on the femoral vein wall, so an approach is planned that will give this safely and yet avoid the scarring of the previous operation and the varices that have developed subsequently in the cicatrix and its surroundings (*see* Fig 226B). The femoral vein and the sapheno-femoral junction are defined above the previous operation by making the incision at the lower border of the Poupart's ligament, *i e* above the crease of the groin through normal tissue (Luke (1954) also advises this approach)

The incision.—A large " hockey-stick " incision is made immediately below and parallel to the inner two-thirds of the line joining the anterior superior iliac spine to the pubic spine and curving down from the latter on to the inner thigh for seven or eight centimetres (Fig 226) This incision is higher than that advised for the ordinary sapheno-femoral ligation, which in the average patient is from one inch below the inter-spinous line (Fig 222B) This entry into the " key " part of the operation is through " virgin " tissue rather than through a scar interlaced with varices The incision passes through the two layers of superficial fascia to the deep fascia The lower border of Poupart's ligament (the inner half) and the pubic tubercle are defined The pulsation of the femoral artery is felt two centimetres outside of the pubic tubercle The exact site of the femoral vein is thus determined, *i e* immediately internal to the artery under the deep fascia which is the femoral sheath. The common femoral vein is uncovered by incising its sheath longitudinally on its antero-medial aspect and tracing it downwards for 1½ to 2 centimetres As the vessel is dissected the stump of the internal saphenous vein will be seen protruding from its anterior surface Sometimes it is scarred and adherent

but usually it separates normally from its surroundings The tissue round the saphenous and femoral vein is very gently detached by opening the rounded points of curved Mayo scissors between them taking plenty of time. Working on the *nude* vein wall it is possible to define the sapheno-femoral union and to ligate it twice passing the ligature on an aneurysm needle This will control the main source of the retrograde hypertension. If any tributaries of the internal saphenous vein remain (and they are often all present) or if any join the femoral vein superiorly they are divided

There is an invaluable anatomical feature here that assists the procedure it is that immediately beyond the sapheno-femoral union the femoral vein is passing quickly backwards and downwards into a deeper plane than that in which it was first found Thus by continuing the dissection of the internal saphenous end in this initial level it can be defined all round without fear of injuring the femoral vein which is disappearing deeper out of harm s way A tiresome haemorrhage can arise by an inadvertent laceration of a dilated deep external pubic vein joining the sapheno-femoral line on its inner aspect. A sucker is invaluable to remove the blood quickly enough to show its exact source. Dainty cautious dissection is the better policy

As in the primary operation, after the strategic ligation of the source of high intravenous pressure *i.e* usually the sapheno-femoral union, the procedure aims to remove or destroy the entire internal saphenous trunk preferably by stripping it. The mass of varices here may be formidable because of their extent, thinness and friability It is gradually freed from the deep fascia and glands and is excised by working round it. The bleeding may still be consider able from the circulation from the leg. The other end of the saphena magna unless it is quickly found is best left until an indication of its whereabouts is obtained by passing the stripper into it from the ankle or knee. This is usually possible. It will be located lying on the deep fascia The stripper is brought out of it and the trunk is removed as already described

Sometimes the stripper long needle or catheter cannot be passed along the saphenous trunk because it is narrowed rigid or pouched. In such instances it may be possible to remove the trunk by a Mayo stripper

Operation on the recurrent varicose external saphenous vein.—After making the diagnosis varicosity of the external saphenous vein is treated as are those which have not been operated on *i.e* by tracing its trunk from the ankle to its termination at the popliteal space The stripper is threaded upwards as far as is possible It may pass to and impact at the sapheno-popliteal union or at the point where the vein was divided at the previous operation With the latter its tip is exposed at the obstructed place and this length of vein is stripped The sapheno-popliteal union may remain to be defined The vein has usually been divided two to five centimetres distal to the sapheno-popliteal junction The scar tissue of the previous ligation sometimes interlaced with a mass of varices, makes the dissection of the

popliteal space difficult. Before the operation, an attempt is made to locate the proximal end of the external saphenous vein by palpation while the patient is standing The tourniquet tests are done at the different levels Phlebography is of further help These will give an idea of its whereabouts

If the sapheno-popliteal junction is located, a large transverse incision is made over it If not, the wound is extended into the S incision down the sides of the popliteal space, for a full exposure is essential The mass of varices is dissected out through an ample incision An early aim is to define the popliteal vein in the upper and lower parts of the popliteal space, being parts which have not been disturbed before. The vein is followed up and down until the union of the external saphenous vein with it is found For safety, too, the popliteal artery and the tibial nerves (internal and external) are located and studiously avoided The sapheno-popliteal point is ligated twice and divided The procedure may take one to one and a half hours of exacting dissection The picture may be confused by persistence of the tibial venae comites and several mucular veins about the popliteal vein which are also defined so that identification is correct

The external saphenous vein may pass through the popliteal space, having little or no connection with the popliteal vein, to terminate in the muscular veins of the thigh or in the terminal section of the internal saphenous vein

Coincident recurrent internal and external saphenous vein incompetence with eczema and ulceration.—This presentation is found occasionally and it is treated as already suggested, the internal and external saphenous vein and their trunks being removed to their terminations Should the eczema or the ulceration be intransigent, the sapheno-femoral ligation is made and the saphenous trunk is stripped to the upper level of the skin disturbance. The external saphenous vein is similarly treated at another session

This is usually followed by healing, after which the saphenous trunks remaining at the ankles upwards are removed Particularly are incompetent communicating veins in the ulcer area sought for and if found ligated This is vital when ulceration is or has been present In 1954, of thirty-three recurrent internal saphenous veins operated on by one of us, ten also had defective supra-malleolar communicating veins

Recurrences due to incompetent communicating veins.—Recurrences due to incompetent communicating veins present no difficulties. They have usually not been diagnosed at the first operation and therefore are straightforward surgical exercises in locating the orifice in the deep fascia through which the vessel passes

These communicating veins have been found as follows —

1. Over Hunter's canal
2. Passing into tensor fasciae femoris

3 At the internal condyle of the tibia.

4 The mid-calf at the musculo-tendinous junction of gastrocnemius this may be an anomalous ending of the short saphenous vein

5 The inner ankle communicating veins (Figs 229 and 32)

6 The lateral ankle communicating vein (Figs 230 and 43)



FIG. 229

A persistently swollen leg due to incompetent perforating veins at the ankle. A sapheno-femoral ligation and sclerosing injection has been made into the saphenous trunk. Later an extra fascial but incomplete ligation of the ankle perforating veins was done. A sub-fascial exposure with an incision from the internal malleolus to the upper half of the leg gave her relief from discomfort and much of the swelling.

In connection with the last, we are increasingly impressed by its association with an inconspicuous and undiagnosed external saphenous vein We have seen many such instances recently In all the patients the internal saphenous vein had already been efficiently dealt with

The diagnosis of these vessels follows the pattern described in Chapter VI. The treatment of the supra ankle communicating veins is detailed in Chapter XVII.

TREATMENT —The incompetent perforating vein is divided between ligatures If the superficial varicose vein is large it is excised as far as the incision allows and the remaining stump is injected with 2 - 3 ml. of sclerosant, followed by the usual pressure bandage for fourteen days



FIG 230
A case of varicosity of the external saphenous vein and incompetent ankle perforating veins with ulceration at both malleoli The sapheno-popliteal ligation and retrograde injection of the external saphenous trunk was followed by keloid scarring of the longitudinal incision and rigid pes equinus The patient was relieved by excision of the cicatrix, lengthening of the tendo-Achillis and ligation of the ankle perforating veins She is an example of incomplete diagnosis and treatment complicated by scarring

Conclusion.—Recurrent superficial varicose veins can be cured or greatly relieved if the time is given to make a diagnosis, to plan and to execute a radical treatment The re-operation takes an hour or more The by-passing veins are always thin-walled, tortuous, numerous and fragile; the occasional gross haemorrhage and dissection in scar tissue call for patience and skill

Only those trained in venous procedures should undertake operations for recurrent varicose veins and always with adequate assistance instruments, and a sucker in case of heavy haemorrhage.

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CHAPTER XI

SUPERFICIAL THROMBOPHLEBITIS IN THE LOWER LIMBS

INTRODUCTION.—The traditional treatment of spontaneous thrombophlebitis in superficial varicose veins is that of four to six weeks' strict confinement to bed with the affected limb immobilised between sandbags, and pain-relieving medicaments (*e g* glycerine and ichthyol) applied to the affected veins This practice is based on the belief that such immobilisation will prevent the detachment of a portion of the clot into the venous stream to become a pulmonary embolus Many patients continue to be so treated We submit that such prolonged rest for superficial thrombophlebitis is unnecessary and slightly dangerous and that it can be safely and effectively replaced by a plan of progressive ambulation and early operation (sapheno-femoral ligation for internal saphenous incompetence) with the saving of morbidity and time This method has been advocated since 1928 One of us has practised it since 1940 and no untoward or unfavourable incidents have occurred

The traditional treatment is open to the following criticisms

1 First the liberation of a clot into the blood stream is unlikely, as it is firmly attached to the tortuous and beaded varicose veins wall by the prominent inflammatory reaction which obviously includes the entire vein, and the perivenous tissues so that in any posture embolism is unlikely

2 Immobilisation of any adult patient is conducive to a sluggish venous flow in the legs and hence, in the presence of thrombophlebitis, the propagation of the thrombus and possible extension into the perforating and deep veins from which an embolus *could* originate is the real danger. Therefore movement rather than rest is the safer state, because while blood is circulating briskly, it is unlikely to clot

3 Finally, an attack of thrombophlebitis treated by immobilisation achieves nothing. In the following months the thrombus will resolve and the affected veins will recanalise and the patient will be as before Clinical and pathological observations show that the reaction from the vessel wall and adjacent blood stream digests the clot and large solid veins completely recanalise in three to six months The varicosities remain liable to further phlebitis, for thrombosis, as Raeburn (1951) emphasises, is prone to be repetitive

Thus the conventional rest treatment of superficial phlebitis is unnecessarily time-consuming and disabling, it is dangerous from the possibility of extension of the thrombosis to the deep veins and embolism It does nothing to avoid further attacks, nor to cure the varicose veins

The ambulatory and operative treatment of thrombophlebitis is advocated to replace the ' rest treatment because it is more effective safe time-saving and curative.

THE CAUSES OF SUPERFICIAL THROMBOPHLEBITIS (*see also* Chapter XII)

1 *In varicose veins*—Superficial thrombophlebitis in varicose veins often occurs spontaneously in adults or after a local injury such as a bruise, knock or fracture after an operation associated with immobilisation especially one below the diaphragm (*e g* cholecystectomy or prostatectomy) after pregnancy or an illness Half of the cases of thrombophlebitis arise spontaneously in persons apparently well (Allen *et al* 1955)

Deliberately induced chemical phlebitis from sclerosing injections has already been described (Chap VII) and will not be further considered Akin to this is the painful thrombophlebitis in the internal saphenous vein that develops during a continuous drip into this vessel One unit of Heparin (Toronto unit) per ml of infusion will delay its appearance Otherwise both are managed by pressure bandaging ambulation as far as possible and sedatives as necessary

2 *Phlebitis in non-varicose veins*—Phlebitis may occur spontaneously in non-varicose veins and it is usually significant of an underlying serious condition. Thus phlebitis migrans may be an early sign of Buerger's disease (thromboangiitis obliterans) usually in the male in the thirties Malignant disease elsewhere such as cancer of the stomach pancreas or lung is always considered when phlebitis arises in those in middle life Appropriate investigations must be made therefore Further thrombophlebitis may be present in varying degrees around infective foci on the limbs (acute and chronic) in gangrene and tumours in severe systemic disease such as pneumonia typhoid, blood dyscrasias but in these types the phlebitis is clearly subordinate and is not the prominent condition that is tending to incapacitate the patient and to demand treatment.

The interesting axillary thrombophlebitis is not considered here.

The factors in thrombophlebitis are —

1 A lesion of the vessel walls (varicosis or a blow and the subsequent inflammatory reaction)

2. A sluggish circulation as with prolonged standing, sitting with the legs dependent (as in cardiac disease) or immobility in bed

3 Modification of the clotting power of the blood is an attractive possibility but this has not been demonstrated

De Takats (1932) believes that infection is an aetiological factor Govaerts (1928) considered that avirulent organisms predispose to thrombophlebitis. Silent septic foci such as at the roots of teeth especially dead ones or in tonsils and antra are sought for

THE SYMPTOMS AND PHYSICAL SIGNS OF SUPERFICIAL THROMBOPHLEBITIS—These are general and local There is usually a degree of malaise quickened

pulse and raised temperature varying according to the extent and severity of the thrombosis and the reaction around it The pyrexia impresses those who are guided more by the thermometer than the patient's general condition. The suddenness of the onset always raises considerable apprehension.

Locally, the thrombosed varices are obvious. There is the usual inflammatory reactions of heat, redness, pain and swelling around it The thrombosis may be a localised cluster of subcuticular varices on the leg or thigh. The

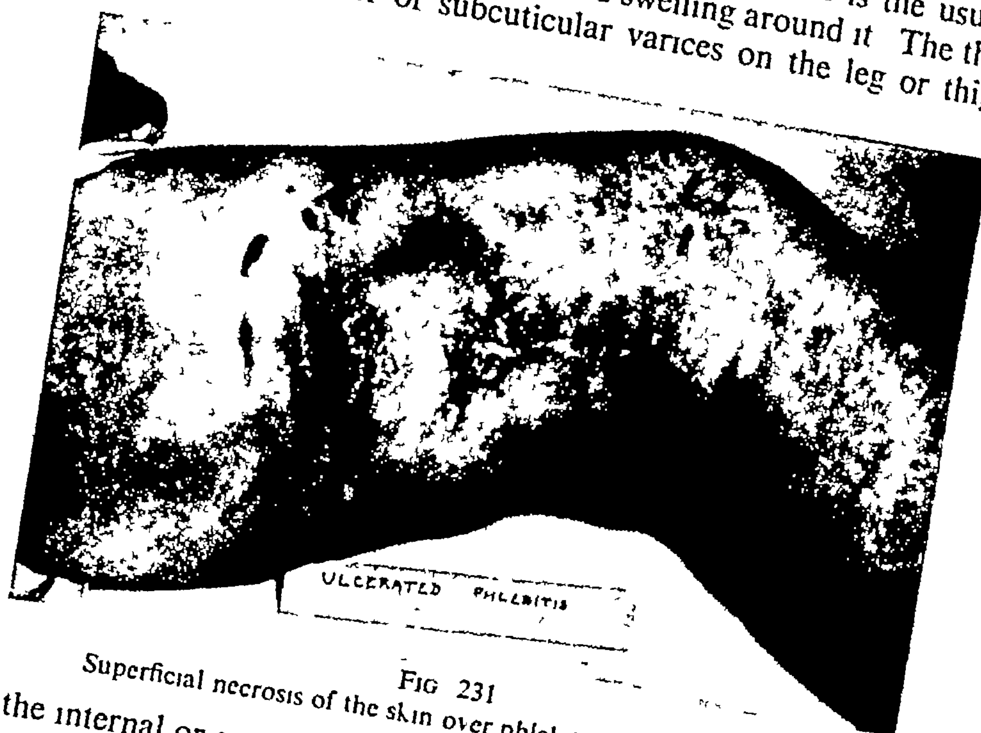


FIG 231

Superficial necrosis of the skin over phlebitis in varicose veins.

trunk of the internal or external saphenous vein may be affected and converted into a large, tender, solid cord of varying length In a few days it may extend from the ankle to the foramen ovale The inflammatory reaction varies from being slight to severe; in the latter the adjacent skin is reddened, thickened and indurated Occasionally it proceeds to a small patch of necrosis (Fig 231). Sometimes fluid collects beneath it as indicated by fluctuation, but it is usually absorbed ; or aspiration by needling clears it. Very rarely a superficial abscess forms and requires incision

The pain at first makes movement difficult, and may approach incapacitation, but this is rare; fear is the chief immobilising factor.

The tributaries of the internal saphenous vein in the leg and thigh are variously involved Occasionally the superficial epigastric and superficial circumflex iliac veins in the lower abdominal wall become solid in an extensive thrombophlebitis, with peri-phlebitis and pain. The extension to the abdomen adds to the concern of the patient and occasionally to that of the doctor.

THE DEEP VEINS AND A SWOLLEN LEG —The thrombophlebitis very rarely spreads to the deep veins It would be indicated by some tenderness of the calf muscles, especially on dorsi-flexing the foot, with oedema and cyanosis

yards long is wound from the roots of the toes to the groin as after the stripping operation (Fig 232) Considerable tension is used to compress and reduce the swelling The bandage is reapplied morning and evening to adjust it and to take up the slack This pressure bandaging and padding of the limb lessens the pain The *crêpe* or stockinette bandage under elastic webbing is necessary because the latter is rough when applied directly to the skin and makes it sore The bandaging is continued until the tenderness and swelling have subsided for two weeks and normal activity is fully resumed

The operative treatment of superficial thrombophlebitis in varicose veins.—As it is mainly the varicose internal saphenous system in which the phlebitis occurs, so the operation is usually on this vessel It consists essentially of sapheno-femoral ligation and terminal division of the saphenous trunk

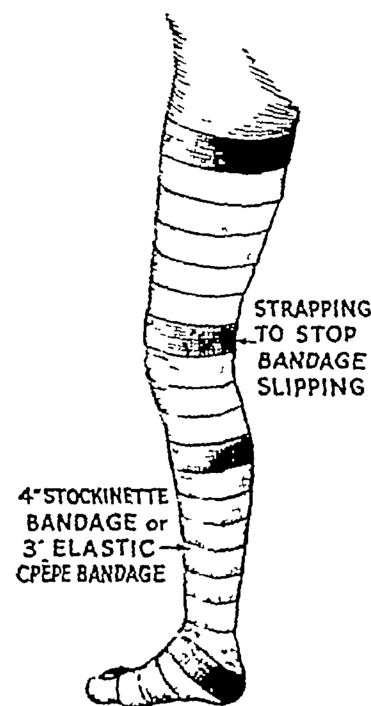


Fig 232
A limb with superficial phlebitis bandaged

Others (Homans (1928), O'Neill (1931) Stone (1932), Sears (1935), Edwards (1937) and Barrow (1949)) agree that ligation is good treatment It is done as soon as it can be conveniently arranged after the condition has declared itself As the patient is ambulatory immediately after the operation, it is complementary to the bandaging and the activity already sketched

A light general anaesthetic or local analgesic is used

Incision—The termination of the varicose internal saphenous vein is exposed through an ample incision a little higher than the sapheno-femoral union so that undue handling of the thrombosed internal saphenous trunk and the possible detachment of a fragment of a clot from within it is avoided (Chap. VIII)

Sapheno-femoral ligation—The sapheno-femoral junction is defined and doubly ligated The internal saphenous trunk is tied one centimetre lower and cut between the lower ligatures In thirteen cases operated on, the thrombus in the internal saphenous vein stopped short at one or two centimetres of its ending and there was sufficient normal vessel to tie and divide without including thrombosed vein.

In three patients, the clotting extended from the ankle to the lower abdomen; it had involved the superficial epigastric, circumflex iliac and external pudic veins, but the last centimetre of the internal saphenous vein was unthrombosed

Injection—After the ligation, the distal end of the internal saphenous vein may be injected slowly with a sclerosing agent, through a hypodermic

sapheno-popliteal union is ligated in the popliteal space and the thrombosed saphenous trunk is injected with 2 3 ml of sclerosant.

Stripping.—Stripping is inadvisable in the presence of thrombosed varices lest some of the thrombus is displaced from them into the deep veins In one patient, operated on routinely for varicose veins an unnoticed thrombosed vein was stripped and a non-fatal pulmonary embolus followed.

Excision of thrombosed veins.—Where the thrombosed varicose veins are very large and the skin over them is inflamed excision of them may be considered although we have never found it necessary With the continuous pressure bandage, huge masses of thrombosed veins have disappeared in a few months.

Microscopic section of the saphenous trunk.—The following is the report of a microscopic section of a portion of the thrombosed long saphenous trunk which was excised after the sapheno-femoral had been ligated "Sub-intimal thickening due to fibroblastic infiltration capsular congestion and lymphocytic infiltration." This shows that the affection is of the whole vein wall

"*Follow-ups*.—Follow-up inspections of over four years confirm the effectiveness of this ambulant remedy for superficial thrombophlebitis in varicose veins The oedema has quickly subsided and with encouragement and sedatives, these patients have been continuously active No systemic incident has occurred to suggest an embolus or ill-effects

As in the after-treatment of other presentations of varicose veins unthrombosed outlying varicosities are injected at the subsequent periodic visits

"The combined ambulatory and operative treatment of thrombophlebitis of varicose veins is now agreed to be best (Oldham 1951) In our experience, time has proved this to be true

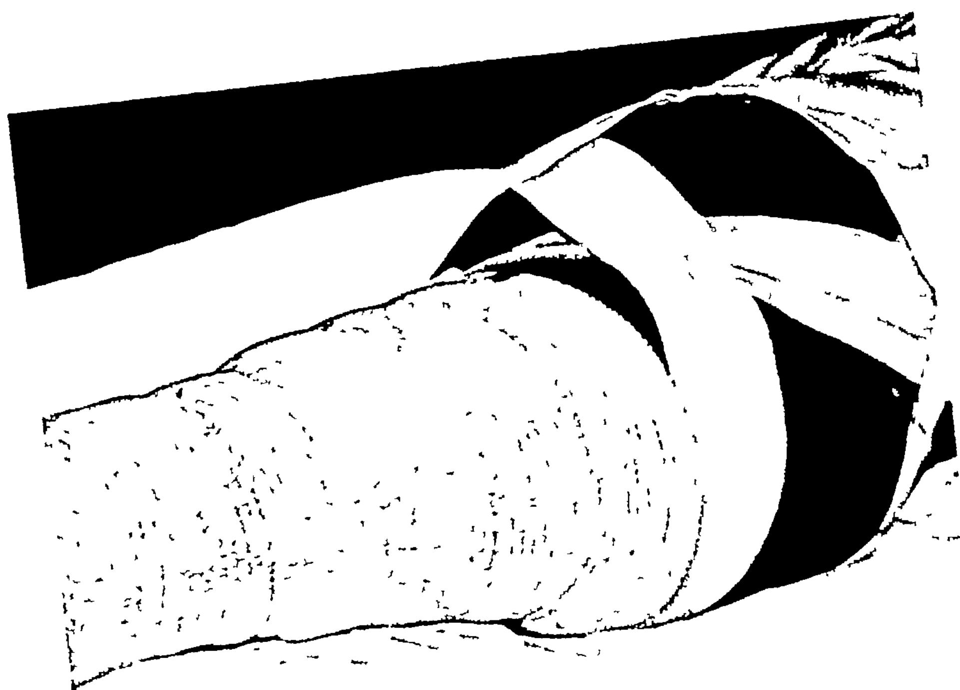
Effusion or infection about veins.—Occasionally in cases of very severe thrombophlebitis an effusion occurs about the thrombosed veins This is treated by applying a large pad of cotton wool and giving extra attention to the pressure bandage. Rarely the fluid requires to be aspirated, possibly twice One of us has had to incise a small abscess that developed between the skin and the veins. It was associated with a little scaly eczema over the varices During the phlebitis, a patch of skin necrosis and suppuration appeared but this was exceptional

POST-OPERATIVE OR POST PARTUM SUPERFICIAL PHLEBITIS

Superficial thrombophlebitis may develop spontaneously after operation child-birth or a medical illness. It must be diagnosed from deep phlebitis These conditions may occur separately or together (for deep phlebitis *see* Chapter XII) Superficial thrombophlebitis is prone to appear in any adult with varicose veins who is immobilised.



B



C

Fig 233

The bandaging and dressing of a limb with superficial thrombophlebitis after sapheno-femoral ligation A—shows the sterile crêpe bandage round the limb and the elastic crêpe bandage with a loop beginning round the foot B—shows the groin wound being dressed with Diachylon strapping C—the bandaging is complete

PART III

PATHOLOGY AND SURGERY OF DEEP AND COMMUNICATING VEINS

When superficial thrombophlebitis complicates a grosser condition, this obviously takes precedence, but the phlebitis is managed on the ambulatory plan outlined, as far as the major ailment permits it

SUMMARY OF TREATMENT

1. *Continuous pressure bandaging* of the affected limb, to limit the spread of the thrombosis, to relieve the discomfort and accelerate absorption

2. *Ambulation*—The patient gets up and walks as soon as permissible Exercises in bed are encouraged Pending radical treatment, the limb is kept firmly bandaged, or elastic stockings are worn

3. *Active treatment of the varicose veins.*—When the patient's recovery is adequate, according to the diagnosis, sapheno-femoral or sapheno-popliteal ligation is done, sclerosing injections are made and pressure bandaging is maintained for three to four weeks

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CHAPTER XII

THROMBOSIS AND EMBOLISM

INTRODUCTION

DURING the past half-century thrombosis of the deep veins more especially of the leg and thigh has been recognised as a common and serious complication following accidents operation childbirth or severe illness of any sort. It is of great importance for two reasons *First* because of the danger of pulmonary embolism—fatal or non-fatal this is well known and dramatic *Second* because of the chronic sequelae of thrombosis of the deep veins of the legs These are less well known and less dramatic However up to seventy-five per cent of people who have acute thrombosis of the deep veins of the legs suffer for the rest of their lives from oedema induration ulcer or pain in the lower leg. The reason why this sorry aftermath of deep thrombosis has not received the publicity it deserves is that these symptoms occur after a latent period of two or three years and it was some time before the cause and effect relationship was established.

In contrast, thrombosis confined to the superficial veins does not lead to either of these two sequelae usually and with relatively rare exceptions is a benign disease

The first published clinical report of a death from pulmonary embolism was in 1866 by Spencer Wells and it was during the ensuing period following the rapid growth of Listerian surgery and anaesthetics that thrombo-embolism gradually became an ill understood and feared complication This was in spite of the fact that Virchow (1846) had worked out the pathological concept of thrombo-embolism almost as we know it to-day from his *post mortem* observations.

In spite of this early start, the problems of prevention early recognition and treatment of this disease have only recently been understood and in the voluminous literature on the subject there is still a good deal of disagreement on all points. In fact, as DeBakey (1954) in an exhaustive study of this literature, says "Few conditions in medicine have been subjected to so much analysis with so little elucidation." However in spite of this pessimistic conclusion the authors believe that certain basic pathological and clinical facts about the disease have been established, and a rational method of treatment and prevention can be recommended.

Incidence of the disease.—Statistics purporting to give the incidence of early thrombo-embolic disease in large series of cases are apt to vary considerably and be misleading. The reason for this is two-fold (1) the early

and particularly in the large venous sinuses of the soleus muscle of the calf (*see* Figs 234 and 235) The evidence for this comes from three separate lines of research —

1 CLINICAL —The signs associated with calf thrombosis, *i e* calf tenderness, swelling and oedema and duskiness of the ankle and foot are noted clinically as the first evidence of deep thrombosis in the majority of patients

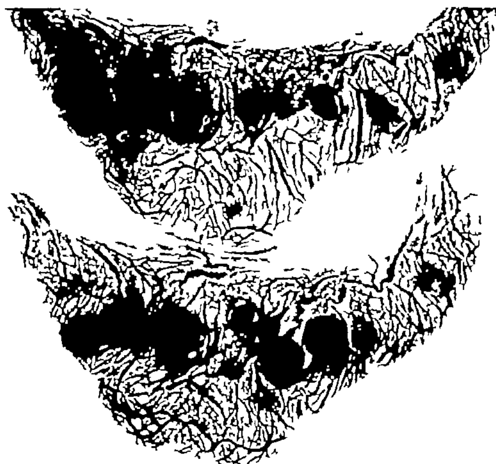


FIG. 234
Transverse section through the soleus muscle of a patient who died from pulmonary embolism Note the thromboses in the large *intra* muscular venous sinuses.

2. VENOGRAPHIC.—Bauer (1946) concluded that thrombosis began in the calf veins in the majority of cases

3 POST-MORTEM STUDIES —If a series of post mortem dissections of the venous system of the leg is carried out on either unselected cases or patients who have had evidence of thrombo-embolic disease in life, ante-mortem thrombi in these calf sinuses are found in a high proportion of cases Thus Raeburn (1951) in one hundred and thirty unselected necropsies found calf thrombosis in thirty-five of these thirty-five cases twenty showed large emboli

in the lungs Similar observations have been made by Rössle (1937), Hunter *et al* (1945), Greenstein (1945) and ourselves

However, McLachlin and Paterson (1951 and 1954) have pointed out that this is by no means the only place in the lower limb in which thrombi originate

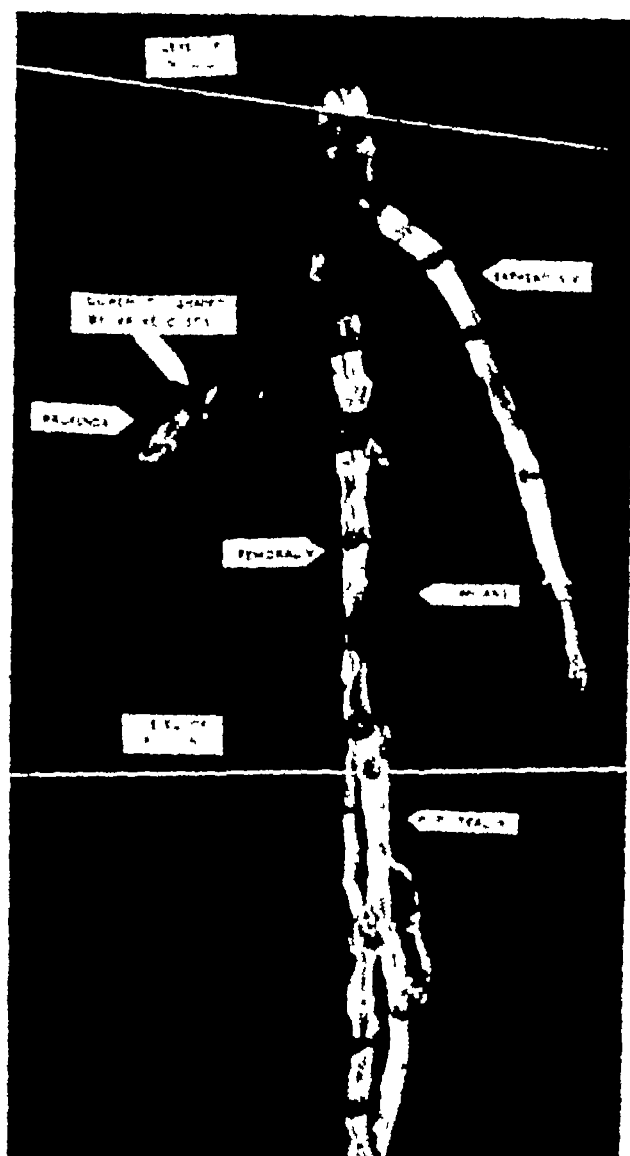


FIG 235

Ante mortem thrombus arising in profunda vein

In a significant proportion of their material, thrombi were found in the thigh veins, and a few in the pelvic veins, with the calf veins clear. Moreover, they point out that many thrombi in the larger veins originate in relation to a valve cusp Figure 235 is the photograph of the vein dissection of a man who died of pulmonary embolism In this case the embolus originated from a thrombus which started in a valve cusp in the profunda vein In another case (Fig 239)

of the authors, a fatal embolus occurred on the tenth day At autopsy no sign of thrombosis could be found in either leg despite a complete exploration In this case the right internal iliac vein was solid with clot and the ragged edge of the thrombus from which the embolus had broken off was projecting into the common iliac vein

Other workers Carlotti *et al* (1947) and Fowler and Bollinger (1954) who have included large numbers of cardiac failure autopsies in their series draw attention to the fact that thrombus may also be found in the *right* auricle in these cases, and pulmonary embolism may arise from this source in this group of cases Fowler and Bollinger considered that the right heart was the source of fatal embolism in thirty-eight of ninety-seven fatal cases studied at *post mortem* They point out that in many cases the embolus occurred soon after auricular fibrillation had been controlled or converted to normal rhythm with digitalis Miller and Berry (1951) drew attention to this point. However it was the finding of Carlotti *et al* at the Massachusetts General Hospital that, even in cardiac cases most of the pulmonary emboli arose from venous thrombosis in the legs

Thus it would appear that deep thrombosis giving rise to embolism may start in any or all of the following sites —

1 The venous sinuses of the soleus muscle

2. In relation to valve cusps in the main deep channels of the thigh (the profunda and superficial femoral veins)

3 In the internal iliac vein and tributaries.

4 In the right auricle.

It is probable that the site of initiation of thrombus formation is to some extent dependent on the type of case and site of disease Thus in cases of pelvic inflammation and disease (gynaecological and obstetric cases pelvic carcinoma) the pelvic veins are probably the starting point for thrombosis in a high proportion of cases However the consensus of evidence is in favour of the calf veins being the site of initiation of thrombosis in the majority of cases (probably about seventy-five per cent.) Moreover all authors who have dissected numbers of *post-mortem* cases are agreed upon three other points —

1 Thrombosis of leg veins when it occurs is *bilateral* in a high proportion Often the thrombosis is extensive in one leg and slight in the other (*i.e* extensive thrombophlebitis in one leg, clinically manifest, and early phlebothrombosis, clinically silent, in the other)

2. Pulmonary emboli (fatal or non-fatal) are almost never found in the absence of a peripheral source of thrombosis in the limbs, if these limb veins are properly dissected Primary pulmonary artery thrombosis is a very rare phenomenon.

3 Untreated pulmonary embolisation tends to be a repetitive and recurring process (Raeburn 1951)

Deep thrombosis in the upper limb.

1. THE ARM —Thrombosis of the axillary vein occurs commonly in two groups of cases :—

(*a*) Following trauma in radical mastectomy It is the cause of the swollen arm in the *early* post-operative phase of radical mastectomy—as opposed to the lymphatic oedema which typically has a delayed onset

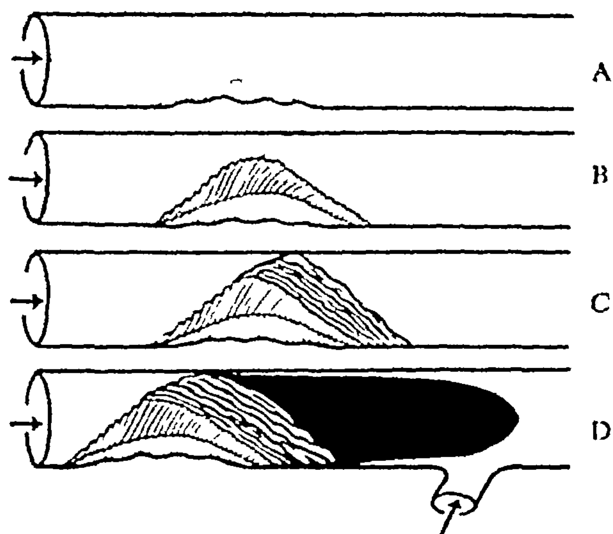


FIG 236
The pathology of thrombosis For description see text (*after Hadfield*)

(*b*) It occurs sometimes in healthy young adults following active use of the arm above the head or in an unusual or strained position. The usual type of activity is painting a wall or a ceiling This is known as stress thrombosis Pulmonary embolism is almost unknown in thrombosis of the axillary vein (although one case has recently been reported by Hughes (1949)) and the symptoms and signs (tightness and oedema) usually subside in from two to four weeks, leaving the limb asymptomatic (Hughes, 1954)

The mechanism and pathology of thrombosis.—The genesis of intravascular thrombosis has been beautifully described by Aschoff (1924) and no better descriptions than his are to be found Hadfield (1950) has recently re-emphasised the importance of this basic pathology. The stages in the formation and natural history of the intravascular thrombosis are shown in the diagrams of Figure 236) Thrombosis is initiated by the fact that the platelets in flowing blood tend to adhere to any irregularity or area of trauma in the vessel wall. Thus the first stage in thrombosis is the formation of a platelet thrombus over a traumatised area of vein wall (Fig 236A) This is grey, amorphous, semi-transparent, and in fact is the natural element with which the blood repairs or smoothes over any wound or irregularity of the intima Whether the process stops here (as it normally would) or progresses into the formation of an occluding thrombus depends on a number of factors, predominant among which are the *size of the vessel* and the *speed of the blood stream* Figure 236B shows the next stage of the process—the addition to the platelet thrombus of the coralline thrombus. This interesting formation consists of a series of upstanding, corrugated, parallel laminae composed of hyalinised platelets, which grow across the stream and are bent in the direction of its flow. The surface of this is traversed by fine, closely set ridges which are the edge of

the platelet laminae—these ridges are known as the "ripple lines of Zahn" If this structure produces significant vascular obstruction stagnant blood plasma and red and white cells are entangled in the eddy distal to the thrombus and coagulation occurs, a laminated red occluding thrombus grows—this is shown in Figure 236c. When the vessel is completely occluded by the thrombus the stagnant column of blood up to the next branch clots (Fig 236d) This is

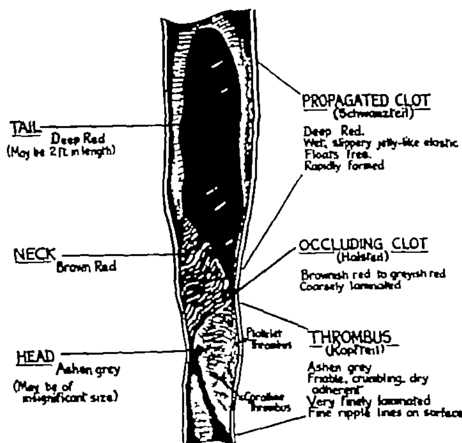


Fig. 237
A fully formed occluding thrombus with loose propagated clot, lying in a vein (*after Hadfield*).

known as *the consecutive clot* If the whole of the blood stream in which this process is taking place is still or sluggish this consecutive clotting may occur for a considerable distance along the blood vessel and is then known as a propagated clot which then gradually contracts *i.e* the normal process of clot retraction. The result is that there is at this stage a long retracted clot, perhaps a foot or more in length, lying free in the vein lumen anchored only to the occluding clot and thrombus proper at the site of initiation of the thrombosis (Fig. 237) This is the situation which is fraught with danger—for this long, free clot only has to break off to become the fatal pulmonary embolus

Now it is important to realise that at this stage of the process (the dangerous stage with regard to pulmonary embolism) there *may be no detect*

able clinical signs present. The free consecutive clot is not obstructing, so there will be no signs of venous obstruction The original area of intimal or venous damage which started the thrombus may be too small to give rise to any clinical symptom or sign. This silent stage of the process has, therefore, been named "*phlebothrombosis*"

Now the next stage is that the consecutive or propagated clot (if it has not broken off and killed the patient) becomes adherent to the vein wall This may take two or three days to occur. When it does occur it does two things: (1) It obstructs a considerable segment of the vein (2) It sets up a sterile inflammatory reaction in the vein wall and perivenous tissues This condition has plenty of clinical signs, and is known as *thrombophlebitis*. The clinical signs will be those of venous obstruction, and of local tenderness over the affected vein, and of general reaction (fever and high pulse rate).

An area of thrombophlebitis in the deep veins of the calf may, if the conditions are right, act as the starting point for a second propagated clot And so it is possible to have *thrombophlebitis* and *phlebothrombosis* together in the same limb at the same time. *They are simply two stages in the natural history of intravenous thrombosis.*

These observations go far to explain many of the anomalous observations on the clinical behaviour of thrombosis and embolism

All observers and writers on the subject have noted that approximately half the cases of *fatal* pulmonary embolism, and many non-fatal cases, occur unexpectedly, with no preceding signs in the legs. Signs in the legs (*i e* signs of *thrombophlebitis*) may occur one or two days *after* a non-fatal pulmonary embolus Remembering also that deep thrombosis is usually bilateral, we may have the following conditions in the legs of a post-operative patient:—

1. Phlebothrombosis in one or both legs. → Asymptomatic, silent, *dangerous*.
2. Extensive *thrombophlebitis* in one leg (clinically a white leg) *with* recent → Numerous signs and symptoms Benign. *phlebothrombosis* in the other leg. → Silent, dangerous.
3. Signs of calf thrombophlebitis, *with* a propagated clot present (*i e.* thrombophlebitis and phlebothrombosis present in the same leg May be bilateral). → Symptomatic and dangerous.

Small pulmonary emboli (too small to have given rise to any symptoms during life) are found on carefully searching the lungs of almost all patients who have died, in whom *ante-mortem* clot is found in the leg or calf veins These studies, and those of Raeburn, have indicated that pulmonary emboli occur much more frequently than one would think clinically An embolus has to be of considerable size before it produces pulmonary infarction and therefore clinical symptoms and signs (Laufman, 1954). Moreover, in

many cases of chronic or recurrent thrombophlebitis of the lower limb it is probable that recurrent sub-clinical showers of emboli occur from time to time. These, by plugging a sufficient number of pulmonary arteries may give rise to pulmonary hypertension and cardiac failure occasionally (Owen *et al* 1953)

Thus consideration of the varied pathology of intravascular thrombosis is essential before we can evaluate the factors influencing the occurrence of the disease, and so develop measures for its prevention and treatment.

The most outstanding factor which was observed by Aschoff (and by Virchow before him) to influence the growth of a thrombus was the *speed of flow of the blood stream* A second factor of some importance was the size of the vessel concerned It is obviously much easier to produce an occluding thrombus in a small vessel than in a big one But it is a prerequisite for thrombus growth that the blood stream should be sluggish A platelet thrombus cannot grow into an occluding thrombus in a fast moving blood stream the platelet thrombus is simply rounded off organised, and finally incorporated into the vein wall by the growth of endothelium over it. *By an appreciation of this fact we have in our hands the most powerful weapon to combat post-operative thrombosis—to find out and use all the measures which increase the venous return from the legs in bed-ridden ill and post-operative patients*

Before considering this further a more detailed appraisal of the factors favouring post-operative or " stasis " thrombosis must be made

The factors predisposing to deep thrombosis.

1 VENOUS STASIS —The most important single factor is the occurrence of a sluggish venous stream—*stasis*—in the legs The main factors which help in returning blood from the abdomen pelvis and legs are —

(*a*) The action of the muscles—particularly the calf muscle pump

(*b*) The negative pressure in the thorax during the inspiratory phase of breathing.

(*c*) The position of the legs relative to the heart. With the feet *down* only effective muscular movement of the calf combined with efficient breathing will ensure an active venous return from the legs With lower limbs raised above the level of the left auricle, however gravity ensures a fast and adequate venous return from the legs in spite of the absence of the first two factors (*i e* muscular action and respiratory suction) This has recently been demonstrated convincingly by Payling Wright (1952) in the striking experiments using radioactive sodium as a tracer element reported in the following chapter She showed that the rate of venous flow from the legs was *quadrupled* as the subject was changed from a position with the feet well below heart level to a position with the feet just above heart level (a ten-degree tilt) Moreover the rate of venous return achieved by this simple manoeuvre was as great as that achieved by vigorous exercise of the leg

muscles ! It is clear that here we have a very simple manoeuvre which will effectively promote the maximum venous flow from the legs in any ill patient confined to bed and which should be effective in both *preventing* and *treating* deep thrombosis

These observations also give the clue to why deep thrombosis (and also when this occurs, embolism from it), are so rare in the arm For with a patient lying in bed most of the arm is at or just above heart level, and the arm is as a rule much more actively used and moved in such patients than the leg

2 VESSEL TRAUMA —In the initiation of thrombosis some trauma or injury to the blood vessel wall may be an important factor In this connection it is probable that injury to the calves of the legs while the patient is unconscious at operation may play a part Thus, with a patient lying on his back unconscious on the operating table for any length of time, the calves are flattened out and may be compressed over steel fixtures, or even by assistants leaning on them Moreover, in the handling of the unconscious patient, the legs are often not treated very gently, and the calves may sustain trauma which would have been resented by a conscious patient, in such manoeuvres as putting the legs up in lithotomy poles, and transfer from the bed to operating table and back

3 BLOOD CHANGES —Certain changes in the blood itself may predispose to the appearance of thrombosis These are —

(*a*) An increase in the number and stickiness of the platelets It has been shown by Payling Wright (1952) that after parturition and in general after surgical operations (particularly Caesarian section and splenectomy) there is a steady rise in the number and " stickiness " of the circulatory platelets which is maximal from the fourth to tenth day after operation This may have some bearing on post-operative thrombosis

(*b*) An increase in the viscosity of the blood The classic example of this is polycythaemia vera, in which cases recurrent thrombosis, both venous and arterial, are a feature of the disease But, in addition to this, every factor increasing viscosity will operate in this way, and the main conditions of surgical importance are dehydration and oligaemic shock

4 ASSOCIATION WITH MALIGNANCY —One of the most interesting and least explored facets of thrombosis is the tendency for certain cases of malignant disease to present with recurrent venous thrombosis both superficial and deep In the authors' experience, carcinoma of the lung, pancreas and stomach are pre-eminent among these Several cases have been seen in which the patient first presented himself to a doctor with minor recurrent areas of thrombophlebitis of the leg or arm Numerous reports are to be found in the literature commenting on the association of peripheral thromboses with carcinoma of the pancreas, carcinoma of the stomach, and various leukaemias and Hodgkins' disease So distinct is this phenomenon, that it should be a clinical rule that *if a patient in the cancer age group presents himself with*

an unexplained peripheral venous thrombosis a search should be instituted for carcinoma of lung stomach or pancreas or blood dyscrasia in addition to more local causes

CLINICAL PRESENTATIONS OF THROMBOSIS

The fact that a patient has deep venous thrombosis may be signalled clinically in three separate ways

1 By the occurrence of a pulmonary embolus fatal or non-fatal "out of the blue."

2. By the persistence of a low grade pyrexia which fails to settle after operation.

3 By the occurrence of local signs of thrombophlebitis in the limbs

It is most important to realise that a patient may present in any one way alone, or in all three ways together or separated by a greater or lesser time interval. We must now consider these three clinical types in more detail

1 AN EMBOLUS — unanticipated — From our consideration of the pathology of thrombosis it is obvious that if a patient is in the stage of phlebothrombosis there may be a long propagated thrombus floating loose in the leg veins attached only at its lower end This may give no signs or symptoms *at all* until it suddenly becomes detached is carried to the right heart and plugs the pulmonary artery to become a fatal pulmonary embolus If only a small piece of it breaks off the patient may be luckier and the embolus may be non-fatal—this is fittingly called a *warning embolus* It is a caution because it indicates that the patient has phlebothrombosis somewhere—probably in the lower limbs—and unless this is treated energetically and urgently the patient may not be so fortunate with his second embolus

This concept is in accordance with all the observed facts about pulmonary emboli—for nearly all authors (DeBakey 1954 and Marks *et al* 1954) have recorded that approximately half of all emboli both fatal and non-fatal occur without preceding signs of thrombosis in the legs Of course there is another possible reason for this which accounts for some cases namely that the site of occurrence of the *thrombophlebitis* (which may be initiating the propagated embolus clot) may not be in the legs at all but in the hypogastric veins or profunda femoris vein In both places clinical signs of even established thrombophlebitis are slight and undetectable clinically in the early stages In this type of case, however the temperature chart usually signals a low remittent pyrexia and this may be the only indication (*see* Chart Fig 238)

What makes the propagated clot break off and become an embolus ? An old observation that pulmonary emboli often occur when the patient is straining on the bed pan or is beginning to be active has some significance If the passage upwards in the deep veins of some diodone is watched under the X-ray screen, and the patient is then asked to perform the Valsalva manoeuvre (essentially the same as straining on a bed pan *i e*

holding the breath and straining) the veins will be seen to dilate as blood refluxes into them, ballooning out the valves and distending them On cessation of the valsalva maneouvre the veins deflate and the blood is aspirated upwards again, with the gasping inspiration which follows the straining Seeing this, it is very easy to imagine that this sort of reflux distension, and then sudden relief of distension, would produce just enough force to loosen a fragile, slightly attached, propagated clot Violent coughing would have the same effect On the contrary, putting the feet up has precisely the opposite effect The veins collapse, and if there was a long loose clot in the veins, they would tend to collapse on to it and entrap it more firmly.

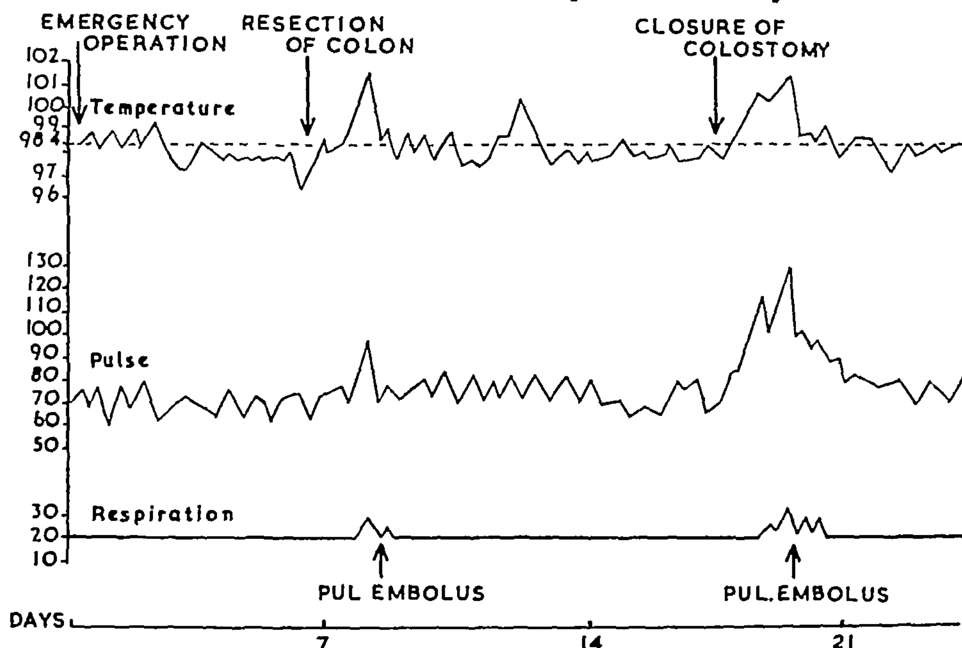


FIG 238

Temperature chart of a patient who had two non-fatal pulmonary emboli On each occasion the patient had a sharp pain in the chest, followed by haemoptysis The chart shows the typical " kick " of temperature and pulse rate which signals an embolus (Almost exactly the same phenomena accompany an acute lobar or lobular atelectasis)

This patient eventually had a third embolus—and both common iliac veins were then tied This terminated his embolic episodes He later left hospital with some residual oedema of his legs easily controlled by elastic bandages

(*By courtesy of Dr J Latto*)

At what time does embolism occur ? As it occurs just as frequently in medical patients and bed-ridden patients who have *not* undergone operation, it can obviously occur at any time However, post-operative embolism does tend to occur at a peak period from the fifth to the tenth post-operative day Pilcher (1937), in his series, found that they occurred at any time from one day to four weeks after operation, but half of them occurred within the fifth to the tenth post-operative days Both of the authors have observed a fatal pulmonary embolus occur on the first post-operative day

Is it easy to diagnose a pulmonary embolus ? Let us consider the fatal ones first The picture of a post-operative patient who is well one moment,

who suddenly has a tense constricted feeling in the chest and is dead in three minutes or so is practically pathognomonic, and diagnosis is a theoretical exercise only However a group of cases exists in whom the embolus is not immediately fatal and the patient may hang between life and death for an hour or two or even longer In this group of cases the diagnosis between pulmonary embolism and coronary thrombosis (especially in older patients) may present real difficulty It is particularly important to know the diagnosis in this small group as it is in these rare cases that the possibility of operative removal of the embolus from the pulmonary artery arises and should be seriously considered Here an electrocardiogram may be of great use and should certainly be done before any operation is contemplated, as the operative exposure of the pulmonary artery in a patient with acute coronary thrombosis would be an error indeed! (One helpful point in these cases is that in pulmonary embolism there is always considerable tachycardia—this is not so with coronary thrombosis.)

Non-fatal pulmonary emboli are easy to diagnose when they present as a sudden pleuritic pain in the chest and cough followed within a day or so by the production of a little blood-stained sputum However it takes quite a large embolus one large enough to block off a segmental artery or more to produce enough pathological change to lead to symptoms and signs (Mathes *et al* 1932) Smaller emboli may produce a transient pleuritic pain, with no bloodstained sputum There is *post mortem* evidence that numerous macroscopic emboli may be present in the lungs without their having been clinically suspected. Laufman (1954) has recently produced good evidence that the picture which we recognise as infarction (*i e* pleuritic pain and blood-stained sputum) only occurs when a fairly large embolus reaches a lung which is already the site of either collapse or infection. This explains why it is so often seen in post-operative cases

Apart from the two phenomena of pleuritic pain and haemoptysis there is another typical sign to be seen on the temperature chart. This consists of a sudden, small transient rise of temperature *pulse* and respiration, which may then rapidly settle. This typical " kick " of all three is shown on Figure 238 and is a valuable confirmatory sign X-rays are of little value in diagnosis as they simply show a small patch of fluffy opacity somewhere, and it may need a very good X-rays and radiologist to pick it up Occasionally a friction rub may be heard over the area of pleurisy and later coarse crepitations may occur Usually the diagnosis must be made clinically and in the less severe cases which have perhaps a transient pleuritic pain only and a slight kick on the temperature chart the diagnosis must be made practically on suspicion! Pulmonary infarcts may become infected in which case the local signs of bronchopneumonia and attendant complications of effusion or empyema may occur

How do pulmonary emboli kill? They kill by simply plugging the whole pulmonary artery leading to acute dilatation of the right ventricle and sudden

failure and ventricular standstill This can be observed in the experimental animal Moreover, in all *fatal* pulmonary embolus cases coming to post mortem, emboli are found blocking *both* pulmonary arteries (Barnard) This "massiveness" is characteristic and constant

2 PERSISTENT LOW-GRADE PYREXIA —This may occur at the same time as the onset of signs in the legs It is more properly a sign of the stage of thrombophlebitis than of phlebothrombosis Its value lies in the fact that when thrombophlebitis is occurring in parts of the venous system not readily accessible to clinical examination (*i e* the pelvic veins, and the deep veins of the thigh) and having, therefore, no other detectable clinical signs, the persistent low pyrexia may be the only clue to its presence An emphatic illustration of this point is seen in Figure 239 In this case the persistent low pyrexia was

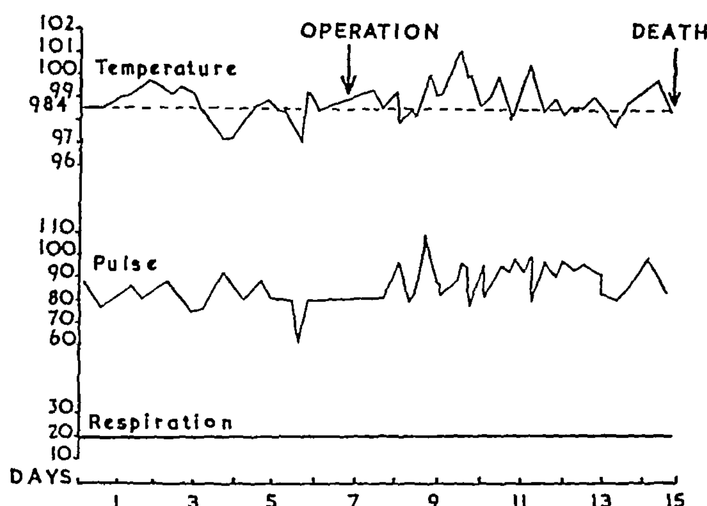


FIG 239

Temperature chart of a patient who died of pulmonary embolism after cholecystectomy There were no physical signs of thrombosis The only abnormality was the low intermittent pyrexia, for which no adequate cause could be found On the ninth post-operative day a fatal pulmonary embolus occurred At post mortem this was found to have arisen from the left internal iliac vein

the only sign of the thrombophlebitis of the pelvic and internal iliac veins, which eventually led to the patient's death from embolism

At this point it may be well to stress that the occurrence of this pyrexia does *not* necessarily mean that a septic process is going on True septic thrombophlebitis gives a different clinical picture, which will be discussed later

3 LOCAL SIGNS OF THROMBOPHLEBITIS IN THE LEGS —As we have seen deep thrombosis in the legs starts in a high proportion of cases in the deep venous sinus within the calf muscles In these cases the spread of thrombosis from the calf to the deep veins of the leg, then up to the popliteal and femoral veins, may take place Each stage of this process presents a definite clinical

picture with clear clinical signs. Conversely when thrombosis originating in a pelvic vein or deep vein of the thigh grows and eventually occludes the main venous outlet of the limb (the common femoral or external iliac vein) this also may present a typical clinical picture of segmental femoro-iliac thrombosis (one type of white leg)

These two modes of occurrence and spread of thrombosis in the limb are summarised in the two figures (Figs 240A and 240B)

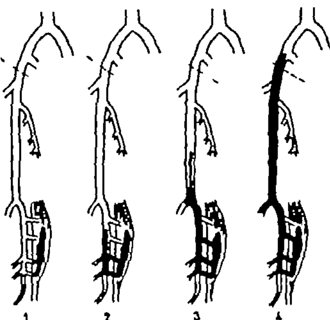


Fig. 240A

Mode of spread of "calf thrombosis."

(1) Confined to sinuses in the soleus muscle.

(2) Spread to involve posterior tibial vein and ankle perforating veins.

(3) Spread upward to involve popliteal vein.

(4) Further spread to involve whole length of femoral vein (white leg)

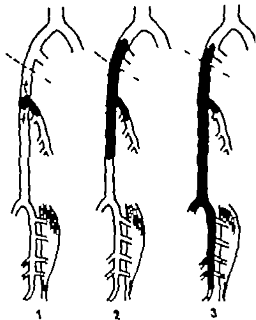


Fig. 240B

Occurrence and possible modes of spread of deep thrombosis originating in femoral or iliac region.

Note that the final effect of spread of thrombosis downwards is the same as that of the spread of calf thrombosis upwards (compare Fig. 240A) giving rise to the clinical picture of a "white leg."

(a) *Spread of calf thrombosis* (Fig. 240A).—The stages which are shown in the figure do not necessarily follow each other in every case as a definite clinical stage The case may present itself as a "fait accompli at stage one two three or four However by a clinical examination a rough estimation of the stage to which the thrombophlebitis has progressed can be made. The table on the following page is intended as a rough guide for the clinical assessment of the degree of spread of the thrombosis.

(b) *Occurrence and spread of femoro-iliac thrombosis* (Fig 240B) —This type of thrombosis, which may start in the internal iliac and pelvic veins or the profunda vein or on a valve cusp in the femoral vein gives rise to a thrombus which may suddenly occlude the main venous stream. When this occurs retrograde clotting in the stagnant column of blood may take place to a

greater or lesser degree, as shown in Figure 240B This retrograde clotting may stop short somewhere in the upper thigh (usually either at the level of the profunda vein or at the level of the adductor canal where numerous branches of the vein occur) (Fig 240B₂) This segmental femoro-iliac thrombosis gives a

CLINICAL GUIDE TO SPREAD OF THROMBOSIS

	Clinical
Stage 1 Thrombosis confined to calf sinuses	Calf tenderness on deep palpation only
Stage 2 Spread of thrombosis to involve a length of post-tibial veins, and the ankle perforating veins	1 Calf tenderness and ? positive Homan's sign 2 *Tenderness and oedema on inner aspect of ankle* Tenderness is sometimes very acute just over the site of the upper and middle internal ankle perforators (Cohen, 1952) 3 Low pyrexia 4 Ankle is warm 5 Duskiness of foot in dependant position
Stage 3 Spread of thrombosis to involve whole of posterior tibial veins, and spreading to popliteal	As above, *plus* 1 Marked oedema of ankle 2 Increase in girth of calf 3 Leg is obviously warm to touch 4 Pyrexia up to 99°-100° F
Stage 4 Spread to involve whole of femoral and iliac veins	Classic picture of white leg, phlegmasia alba dolens 1 Concentric, tense oedema of *whole* limb (leg and thigh) 2 Limb pale or dusky blue 3 Limb *hot* to touch 4 Fever up to 101° F 5 Limb heavy, moved and flexed with difficulty 6 Contrasting appearance with other limb 7 May be tenderness or thickening over course of femoral and popliteal veins

fairly typical picture The onset of venous obstruction is sudden, and the oedema and tenseness are most marked in the thigh, less so in the leg and ankle level. Figure 241 is a venogram of the leg of a woman who suddenly developed this type of thrombosis

On the other hand, if the retrograde venous thrombosis extends down to the popliteal and posterior tibial veins, the classical picture of a white leg may develop overnight (Fig 240B₃) The final clinical picture of phlegmasia alba dolens originating in this way does not differ in any major respect from that which develops by extension of calf thrombosis The only clinical points of note

A

B



C

FIG. 241

Venograms showing the pathology of segmental femoro-iliac thrombosis (A) (Fig. 240B, type 2) and of complete involvement of all the deep veins (B and C) (Fig. 240A, stage 4 and Fig. 240B, stage 3)

All the limbs depicted here showed much the same acute clinical picture — a phlegmasia alba dolens. (Compare with normal venograms in Chap. XIII)

are that in this type of thrombosis (femoro-iliac) there is no premonitory calf tenderness, and indeed this sign may never develop even when venous obstruction is maximal Also this type of white leg may develop with explosive suddenness The typical story is that of a woman who has undergone some pelvic operation, or who has a pelvic carcinoma, who goes to sleep at night apparently normal, and who wakes up next morning with one leg tense, painful and oedematous. This particular type of pathology is more common among gynaecological patients than others It also occurs among patients with malignancy of the pelvic organs from any cause (carcinoma of the prostate or rectum being two of the most common) The man with carcinoma of the prostate who presents with a leg which has suddenly become swollen and tense is a common enough clinical entity



FIG 242
Three months previous to this venogram the femoral vein distal to the entry of the profunda had been tied (as a prophylaxis against embolism) This patient developed no swelling or sequelae of any kind, and the excellent deep collateral circulation via the profunda vein is seen on this venogram, by-passing the short segmental thrombosis which has resulted from the ligature

It should be a clinical rule that any patient who presents with unexplained deep thrombosis of a limb should have a rectal examination and complete pelvic examination done (*see also* p 305)

PHLEGMASIA ALBA DOLENS AND PHLEGMASIA CAERULEA DOLENS

Complete obstruction to the main deep venous outflow of the leg produces the clinical picture known as white leg or phlegmasia alba dolens

There is considerable variation in the *degree of venous obstruction* in case to case, and the exact clinical picture and the speed of resolution of the condition depends almost entirely upon this factor The degree or amount of venous obstruction depends on the following things —

1 On the number of collateral venous channels available anatomically in that particular leg Reference to Figure 34 on page 45 will make this clear It is obvious that thrombosis of the femoral and iliac systems in type (*a*) (Fig 34, p 45) will produce a severer venous obstruction than it would in type (*b*) or (*c*)

2 On the *length* and *situation* of the obstruction Complete thrombosis of the whole length of the main deep veins from calf up to external iliac, or common iliac, produces a severer clinical picture than femoro-iliac segmental thrombosis (Figs 240A, B, 242) The situation of the obstruction is of great importance—in

fact, to produce the picture of "white leg" at all the common femoral vein above the entry of the profunda femoris vein must be involved Occlusions distal to the profunda vein may cause slight transient swelling confined to the lower leg only as in the case illustrated in Figure 242

3 On the extent to which available deep and superficial venous collaterals are also involved in the thrombotic process In most cases particularly those occurring post-operatively or post partum in patients of the younger age group there is little tendency for the thrombotic process to spread out of the main deep veins However in certain cases—particularly the more



Fig. 243

Phlegmasia caerulea dolens.

This patient had had a carcinoma of pancreas resected one year previously The first evidence of recurrence was the appearance of a white leg on the left side. This subsided, but was rapidly followed by a deep thrombosis of the right leg of a more severe and widespread nature—shown here. As a result of this the patient's toes and forefoot became gangrenous.

aged and those who have a predisposing cause for thrombosis such as carcinoma (particularly lung pancreas stomach—or locally in the pelvis) or some blood dyscrasia such as polycythaemia vera—there is a tendency for the thrombosis to spread to the venous collaterals as well In these cases the venous obstruction is very severe and may be so complete as to block practically all arterial inflow into the more peripheral part of the leg, producing gangrene of the toes or foot These are the cases which have been named clinically "blue phlebitis" or "*phlegmasia caerulea dolens*" (Fig. 243)

From these considerations it will be observed that the clinical picture, the speed of resolution and the prognosis can vary considerably However the main clinical features are as follows —

1 History the condition may occur quite suddenly (*e g* the patient may go to sleep with a normal leg and wake up in the morning with a painful swollen leg) or it may occur as a spread of calf thrombosis (Figs 240A, B) with a history of calf pain and ankle swelling preceding the onset of the white leg.

2 The leg is painful, tense, there is concentric swelling and oedema from toes to groin The colour may be pale to dusky blue according to the severity of the obstruction and the amount of oedema

3 In the early stages of the obstruction the toes and foot may be cold, but usually this passes off within twelve hours, and often by the time the clinician sees the case the whole limb is *warm* to the touch, and this persists until the oedema subsides This early and transient coldness of the toes and foot has been attributed to arterial spasm by many authors, and is the reason why sympathectomy or sympathetic injection has been recommended In view of the fact that it is so transient in most cases, the rationale of this procedure is questionable (*see* treatment) However, in the more severe cases (phlegmasia caerulea dolens) the coldness of the toes, foot and leg may be marked and may persist for days or weeks

4 The patient's temperature is elevated—and he may run a fever up to 101° F This is *not* indicative of bacterial infection

5 There may be deep tenderness and induration on palpation over the course of the femoral and popliteal veins This usually occurs early in cases where the thrombosis has spread up from the calf However, in those cases of sudden onset particularly, this sign may be absent It may never occur or it may develop on the second to fifth day after onset

These are the usual clinical features of the average case However, in the patients with more widespread venous obstruction the picture may be more severe Haimovici (1950) has recently reviewed twenty-seven reported cases of phlegmasia caerulea dolens which progressed to gangrene of the foot or toes, and the clinical features are well described in this paper *Severe pain*, with some degree of shock, is prominent at the onset *Swelling* is severe. The whole of the distal part of the limb may be cold and numb Ankle pulses may be absent (in one-third of Haimovici's series) The limb is dusky blue in colour Gangrene of the toes or foot may occur Most cases recover slowly with appropriate treatment In those with peripheral gangrene, in whom there is no carcinoma or thrombotic tendency, the prognosis as regards the limb is good and they may lose a few toes only However, where the process is part of the symptom complex of carcinoma of lung, pancreas, stomach, etc , then the gangrene may extend and necessitate a thigh amputation Even in these cases, on dissection of the amputated member, the arterial tree is found patent to the toes, and the gangrene is purely of venous origin, due to mechanical blockage of all venous egress from the part

Phlegmasia caerulea dolens, with gangrene of the fingers, has also been reported in the upper limb (Haimovici, 1950) Whilst this dramatic state of affairs presents in one limb, phlebothrombosis or thrombophlebitis may exist in the other, but be overshadowed and overlooked until either an embolus occurs or a post-phlebitic ulcer appears two to three years later

SEPTIC THROMBOPHLEBITIS

The forms of thrombophlebitis dealt with in the preceding sections have been aseptic In spite of the fact that the local clinical signs were those of heat, tenderness and swelling, and the appearance of fever and are all signs of infection it is a sterile inflammatory reaction Septic thrombophlebitis occurs and is different in its onset and clinical signs In the legs it is rare being most commonly seen as a result of an infusion into a vein which has become infected There is intense local pain redness and tenderness, and unless treatment is started early spread of the septic thrombosis may occur The classical sign of septic thrombophlebitis of a deep vein is the occurrence of a *rigor* The common places for septic thrombophlebitis are —

1 In the pelvic veins—following a septic abortion or operation on a septic pelvic condition

2. In the lateral sinus—due to spread from mastoiditis.

3 In the cavernous sinus—following a compound fracture of the middle fossa or a facial furuncle.

4 In the leg or arm—following a septic venous infusion wound

5 Portal pylephlebitis—classically following an operation on septic haemorrhoids

Since the advent of antibiotics these conditions have become much rarer but it is important to recognise them at once when they occur The most striking, and often the earliest clinical sign that a septic thrombophlebitis is present is the occurrence of a rigor This should lead to immediate treatment with antibiotics and heparin

TREATMENT

The treatment of deep thrombosis falls under two great headings —

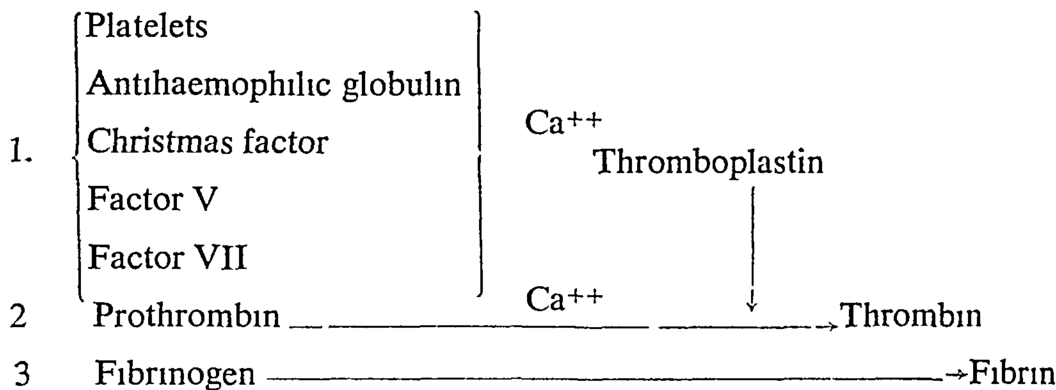
1 The prevention of deep thrombosis (prophylactic treatment)

2. The treatment of the established condition

Of these two divisions the first—prophylactic treatment—is by far the more important. But before going into the details of these two phases of treatment, we must consider certain aspects of the anticoagulant drugs and their place in therapy

THE PLACE OF ANTICOAGULANT DRUGS IN THE TREATMENT OF DEEP THROMBOSIS

Modern concepts of the blood coagulation mechanism may be summarised diagrammatically by the following plasma reactions —



Of the three stages represented, the first, by which thromboplastin is formed in the blood, normally occupies a matter of five or ten minutes in vitro, while the last two together only require about ten seconds for their completion

The "prothrombin time" is the time taken for plasma to clot in the presence of optimum amounts of tissue (usually brain) extract and calcium, that is thromboplastin This time is independent of the platelets, antihaemophilic globulin and Christmas factor, but depends on the concentration in the plasma of factors V and VII and, less critically, prothrombin and fibrinogen By the one stage method of Quick, it is 12 - 15 seconds

The Dicoumarol group.—The Dicoumarol group includes Dicoumarol, Tromexan, Dindevan, and a number of other new synthetic drugs *All* these drugs have essentially similar properties, although their solubility, and therefore the time relations for their absorption and action, differ slightly

The main action of the Dicoumarol group of drugs is to reduce the plasma concentration of Factor VII and, to a lesser extent, of prothrombin For this reason the "prothrombin time" is a most useful guide in controlling the dosage of these drugs Coagulation is not adequately inhibited by them until the concentration of Factor VII in the plasma has fallen to less than twenty per cent of normal

The whole blood clotting time, which, if fibrinogen is present, is essentially an indicator of the state of the first slow phase of the coagulation mechanism (a reaction involving platelets, antihaemophilic globulin and the Christmas factor) is rarely significantly lengthened by these drugs, which do not affect this stage of the process

Heparin.—This is the original anticoagulant discovered and purified by Jorpes The action of heparin is a complex one It is an antithrombin, and it also inhibits the formation of blood thromboplastin Thus it both slows thrombin formation and inactivates the thrombin which is formed. Its dosage is controllable by means of the whole blood coagulation time, which is prolonged by its action

COMPARISON OF THE PROPERTIES OF THE TWO GROUPS OF ANTICOAGULANT DRUGS

Heparin	*Dicoumarol Group*
1 Must be given by injection (intravenous, intramuscular or subcutaneous)	Is given by mouth.
2. Action is *immediate* when given intra venously but may be delayed not more than an hour or two by either of the other routes	Action is delayed from twelve to forty eight hours, according to the drug used
3 Action lasts three to four hours only (intravenously) (but up to twelve to twenty hours with concentrated preparations subcutaneously)	Action lasts up to forty-eight hours or more after cessation of drug.
4 Action certain	Action uncertain subject to the vagaries of absorption, excretion and patient idiosyncrasy
5 Antidote Protamine (dose 5 10 c.c of 1 per cent. solution)	Antidote Vit. K (by injection) 10 50 mg.

Before passing on to a discussion of which drug should be used in the treatment of thrombosis, and how to use it, we must keep clearly before us the objects we hope to achieve by their use. It will be recalled that the essential basic process of thrombosis is

Platelet thrombus———→Vessel occlusion———→Propagated clot

Now all that an anticoagulant drug can do is to stop the formation of the propagated clot, or to stop it from propagating more if it is already present. There is some evidence that heparin also interferes with the formation of platelet thrombus (Payling Wright, 1941)—a most important property Dicoumarol apparently does not have this power Neither of them has any action on clot or thrombus once it has been formed—*i.e* there is no "dissolving" action Thus the clinical basis for the use of these drugs is either —

1 The diagnosis of a state predisposing to thrombosis (in which case they can be used prophylactically) *or*

2. In the presence of an early thrombosis, to prevent the formation of further propagated clot.

In order to attain these objectives the dosage and control of administration must be one hundred per cent. effective

Viewed in the light of these criteria, the Dicoumarol and Tromexan group of drugs have certain disadvantages These are as follows —

1 Delayed action

2. Extreme variations in absorption action and excretion rate

3 Most important difficulty of control These drugs have to be pushed to the stage of almost complete disappearance of prothrombin from the blood before an adequate effect on the actual whole blood clotting time is apparent

This entails very close laboratory control, with estimations of prothrombin time (a technical process requiring some experience) once or even twice daily and adjustment of the dose accordingly In the absence of this strict control, it is doubtful if more loosely controlled and probably inadequate dosage has the desired effect. Certainly the long out-patient courses of the drug recommended by some usually have little effect on the clotting process Moreover, if pushed to excess for any length of time, toxic effects, such as nausea, purpura and haematuria, may occur

Recently Wessler (1953) has shown that in isolated vein segments of dogs only very small amounts of prothrombin need be present to produce a fibrin clot By the same method, he has demonstrated that heparin is considerably superior to Dicoumarol in its anticoagulant effect under these conditions He also points out an important fact—namely, that there may be a profound dissociation between bleeding and clotting

To sum up, the Dicoumarol group of drugs probably only achieve the desired effect in near-toxic dosage—which must be closely and expertly controlled under hospital in-patient supervision

Heparin, on the other hand, has three very considerable advantages These are —

1 Immediate action, within half a minute of the intravenous injection of a dose of heparin the clotting time has risen considerably

2 It acts as a direct inhibitor of the clotting mechanism (which is the desired property)

3 Simple control of dosage (The estimation of the clotting time accurately enough to control heparin dosage is a simple procedure, easily carried out)

The disadvantage of heparin is that with the preparations in use at the present time it must be given intravenously, and its action wears off in three to four hours This difficulty can be overcome by the use of Gordh's needle (Fig 244) With this needle in a vein of the arm, three-hourly intravenous injections can be given with ease through the rubber diaphragm over a period of forty-eight hours. After approximately this period it is wise to change the needle to another vein

The intramuscular and subcutaneous routes of injection with the form of heparin available at present are not practicable for three reasons —

1. They are very painful.

2 Occasionally huge haematomas form (*particularly with intramuscular injection*) sometimes so big as to endanger life and require transfusion

3 The vagaries of absorption by these routes are considerable

The newer preparations of heparin.—It has recently been possible to prepare extremely concentrated solutions of heparin with the pure drug Such preparations (Artz and Pulaski, 1953) will soon be generally available A

dose of 1 ml of a solution containing 200 mg. per ml can be given subcutaneously into the anterior surface of the thigh or chest, and will lengthen the coagulation time adequately (*i.e* between three and four times the normal) for a period of about twelve to twenty hours This will probably be the preferred method of using heparin in the future

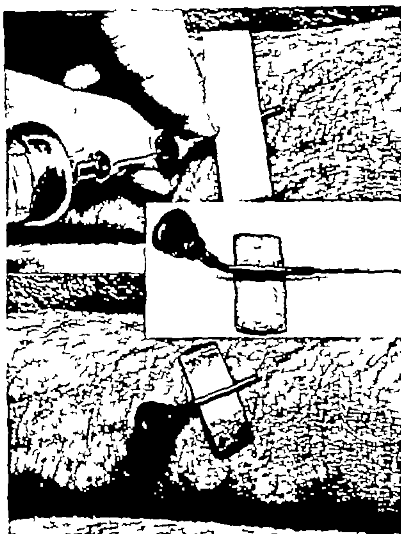


FIG 244
Gordh s needle.

THE TREATMENT OF THROMBOSIS AND EMBOLISM

Ideas on the treatment of thrombosis and embolism are very diverse at the present time. This is in part due to the fact that the essential pathology of the disease is not fully understood, and in part to the fact that too much reliance has been placed on the anticoagulant drugs without any clear idea how they work how to use them and what may be expected of them The scheme of treatment given below is based on what is known of the pathology of the disease, as outlined in the first part of this chapter

Prophylactic treatment.—Prevention is better than cure, and the following points are of importance :—

1 *Gentle handling of the unconscious patient.* Particularly avoidance of trauma when moving the patient and of prolonged pressure to the calves at operation

2 In the early stages after operation, measures to ensure a fast and uninterrupted venous return from the legs must be put in hand at once. These are —

(*a*) *The foot of the bed is raised nine inches so that the feet are just above the heart level*

(*b*) Deep breathing drill, pre- and post-operative

(*c*) Early active exercise of the legs in bed is started as soon as the patient comes round from the anaesthetic.

(All patients should be trained to do these pre-operatively)

3 EARLY ACTIVITY —This is *not* synonymous with the practice of driving the patient out of bed on the day after operation, to sit slumped down in a chair It means that the patient should get out of bed at the earliest possible moment that he can move actively, walk and exercise his legs Early activity *out* of bed is the sequel to the early activity *in* bed that started as soon as the patient came round from the anaesthetic

4 The training of the house surgeons and nursing staff The programme of prophylaxis outlined above cannot be carried out unless all who handle the patient are trained and keenly aware of the problems and dangers of thromboembolism and of the reasons for the prophylactic routine All the nursing staff should know about the early signs of thrombosis and be alert for them

Of all the measures mentioned above, that of raising the foot of the bed until the feet are just above heart level is the simplest, and at the same time the most important (Fig 245) This has been pointed out by Cohen (1952) and, in the experience of the authors, is the most effective method of preventing thrombosis of the leg, and of treating it when present The rationale of the procedure will be found on page 303

The treatment of the established condition.—It will be recalled that the presence of the disease " thrombosis and embolism " may show itself clinically in one of three ways :—

1 As an embolus, fatal or non-fatal (unanticipated)

2 As a pyrexia of unknown origin

3 As a deep thrombosis of a limb with local signs

As these are the three common clinical presentations it is most convenient to consider the treatment of these three types of case

1 TREATMENT OF A PATIENT WITH A SUDDEN EMBOLUS WITH OR WITHOUT SIGNS IN THE LEGS —As we have seen, the quickly fatal case is usually of

this sort and the question of treatment never arises However many non-fatal cases present in this way—with a sudden pain in the chest in the post operative period. More severe cases may show the classical blood-stained sputum and have signs in the chest later (usually in twenty-four to forty-eight hours)



FIG. 245
The anti-thrombosis bed.
By a simple handcrank mechanism the patient's feet can be raised to any desired degree.

The treatment of this condition is a matter of *urgency* The occurrence of an embolus means that somewhere in the venous system, there is a thrombus and fresh propagated clot (phlebothrombosis) The immediate treatment is —

(*a*) Institution of heparin therapy at once—to prevent further propagated clot from forming.

(*b*) Raising of the lower limbs above heart level—to prevent stagnation of blood in them and the pelvis and to increase the rate of venous flow (*i.e* to remove the essential conditions for thrombus formation)

The legs should be kept raised all the time the patient is confined to bed, and active leg exercises should be *instituted* The heparin therapy need not be continued for more than three or four days, its function has been to prevent the immediate threat of re-formation of further propagated clot in the distal veins, and thus further embolism Within four days any clot present will have started to organise and become adherent to the vein wall—*provided* the factor of venous stagnation has been dealt with by raising the foot of the bed, and instituting active movements

If there is any oedema of the legs when the patient gets up out of bed, elastic webbing bandages should be applied from the foot to the groin, being renewed morning and evening

2 THE TREATMENT OF THE CASE PRESENTING AS A PYREXIA OF UNKNOWN ORIGIN —The main difficulty is diagnosis, and treatment is often instituted on suspicion Raising the foot of the bed and giving a short course of heparin for forty-eight hours should not tax the resources of the patient or the nursing staff, and may save a life

3 THE TREATMENT OF THE CASE PRESENTING WITH LOCAL SIGNS IN THE LIMBS —It is our belief that cases which present with signs of calf thrombosis (p 310) should be treated by (*a*) Elevation of the foot of the bed, (*b*) active movements of the leg, calf and foot in bed, and (*c*) firm bandaging from the foot to the groin These measures should be continued until all swelling has disappeared and the calf tenderness is considerably less, or has disappeared Then the patient is allowed up for increasing periods until he is fully ambulant Firm webbing elastic support should be continued until all trace of oedema after an active day's work has disappeared (This usually means that the bandages must be worn for a month to two months after the patient leaves hospital)

Heparin is not considered necessary *unless* embolism is suspected to have taken place when the patient is first seen

WHITE LEG

The treatment of white leg requires care, patience and supervision of the patient for a long time after leaving hospital We shall deal here with the symptomatic treatment, and take it for granted that a *cause* for the white leg (either local—in the pelvis—or general, *e g* carcinoma) has been looked for and dealt with if possible

The only worth-while treatment of a white leg in the early stages is *rest in elevation* This encourages the venous return in the best possible way, at a time when every venous collateral in the limb is being put to full use and is expanding to accommodate the venous flow. Lumbar sympathectomy or injections into the lumbar sympathetic chain and spinal anaesthesia are all *contra-indicated* as these measures increase the blood flow into the

limb at a time when the venous return is seriously embarrassed and they do no good merely disturbing the patient considerably Likewise, if the limb can be properly elevated there is no necessity for anticoagulants

As soon as pain and oedema are obviously subsiding, the patient should be encouraged to exercise the leg, in elevation as much as possible Later the oedema can be helped by massage.

The *other leg* should be elevated at the same time as a prophylactic against the phlebothrombosis which may be in it.

As soon as the oedema in elevation has subsided (this may take one to three weeks) the patient is instructed in the use of the firm webbing elastic bandages, and he is allowed up with these (applied from the toes to above the knee) for increasing periods of activity until he is fully ambulant.

His care does not cease at this point Firm elastic support is necessary for at least six months after the episode, and often for the rest of the patient's life About two years afterwards the effects of canalisation of the thrombosed veins may start to show themselves. This is the stage of the early post-phlebitic syndrome. If early induration changes are beginning in the gaiter area (*i e* the lower third of the leg) or if this area shows early venous congestion this is the time to look for and tie the incompetent ankle perforating veins (*before* advanced and irreversible changes have taken place) Regular supervision and treatment as the need arises will forestall and often completely prevent many of the disabling post-phlebitic sequelae.

This scheme of treatment applies equally to those more severe cases of deep thrombosis known as "*phlegmasia caerulea dolens*" Additional measures may occasionally be necessary In these cases the oedema in spite of the elevation, may be so great and obviously causing so much tension within the tissues and fascial planes of the leg that it may be desirable to relieve it surgically This may be done by either Southey's tubes or by several incisions over the calf and thigh which go down to and open the investing fascia of the muscles of the leg Amputation of the toes foot and very occasionally the leg may become necessary

Thrombectomy—Finally it may be mentioned that occasionally it is possible to operate on patients with femoro-iliac thrombosis extract the clot from the vein and sew the vein up successfully (Mahorner 1954) This treatment however should not be undertaken except by those well versed in the techniques and complications of vascular surgery

Other methods of treatment.—Routine methods of treatment have been outlined for both the prevention and treatment of thrombo-embolism In practice certain cases and circumstances arise in which these methods are not fully applicable They fall broadly speaking into three main groups —

1 Cases in which anticoagulant drugs are contra-indicated

2 Cases in which raising the legs above heart level is impossible or undesirable (*e g* cases of heart failure)

3. Certain cases of "recurrent grumbling" thrombophlebitis with rec rent major or minor embolic episodes—often recurring in spite of, or e whilst on anticoagulant therapy

1 CASES IN WHICH ANTICOAGULANT DRUGS ARE CONTRA-INDICATED These drugs should not be given post-operatively to any patient who l a large granulating surface in the process of healing—particularly if th is some sepsis added Operations such as prostatectomy, abdomino-perin excision of rectum, radical mastectomy, decortication of lung, carry gr risk if put on anticoagulants Severe and sometimes fatal haemorrhage c take place from these granulating surfaces With clean incised wounds a operations such as gastrectomy, colectomy, herniorrhaphy, there is li danger in giving anticoagulants after the fourth or fifth day, provided wounds are clean Anticoagulants are, of course, not advisable when i initial illness of the patient was a haemorrhage from the gastro-intesti tract (such as bleeding duodenal or gastric ulcer) Occasionally enthusias anticoagulant treatment in cases of lung suppuration (broncho-pneumon abscess, etc) has resulted in severe haemoptysis and even death

The use of anticoagulants is not free from danger, and the cases which they are to be used must be chosen with care, and we repeat supervis carefully

2 CASES IN WHICH RAISING THE LEGS ABOVE HEART LEVEL IS IMPOSSIB OR UNDESIRABLE —This includes the great group of mitral stenosis, a other cases of cardiac failure Raising the legs of such patients may ca such an increase in venous return that the heart failure is made worse (the other hand, the position with the legs down and immobile, with veno congestion, is a perfect one for the development of deep thrombosis in t legs, a complication to which these patients are particularly prone Tl problem is assuming more importance since the advent of surgery for mit stenosis Many of these patients suffer from deep thrombosis with recurr minor embolic episodes which may cause serious lung damage, and th control is indeed a problem

3 CERTAIN CASES OF "RECURRENT GRUMBLING" THROMBOPHLEBIT WITH RECURRENT MAJOR OR MINOR EMBOLIC EPISODES —These are fortunate rare, and probably arise through inadequate treatment of the first thromb embolic episode.

For all these cases two further ancillary methods of treatment must l considered These are :—

(*a*) Pressure bandaging of the legs of the bed-ridden patient

(*b*) Venous ligation

(*a*) *Pressure bandaging* of the legs from toes to groin is a good second be to the method of elevation of the limb In order to be effective the bandag must be of sufficient strength and properly applied. These bandag

compress the venous system, particularly of the calf and prevent oedema and stagnation There is evidence that they effectively increase the speed of venous return from the legs of bed patients (Wilkins *et al* 1952 1953) This form of prophylaxis and treatment is most useful for the cardiac groups of patients in which elevation of the legs is out of the question and is well worth while doing in any other type of case in which elevation of the legs is not possible for any reason

(*b*) *Deep venous ligation*—This much discussed operation must be appraised in the light of two important facts These are —

(i) In order to be *sure* of placing a ligature above any possible source of emboli in the limbs or pelvis one must tie the vena cava at its origin on the fifth lumbar vertebra *or* both common iliac veins. Even this somewhat major operation leaves the possibility of pulmonary emboli from clot in the right auricle in cardiac cases.

(ii) A major venous ligation—such as vena caval ligation—leaves a train of disabling sequelae of its own if the patient survives Oedema of the lower limbs, which may take up to six months to settle and always requires the use of firm supporting bandages when the patient becomes ambulant is the main trouble Other post-phlebitic sequelae—ulcers, induration and pain —may follow in time.

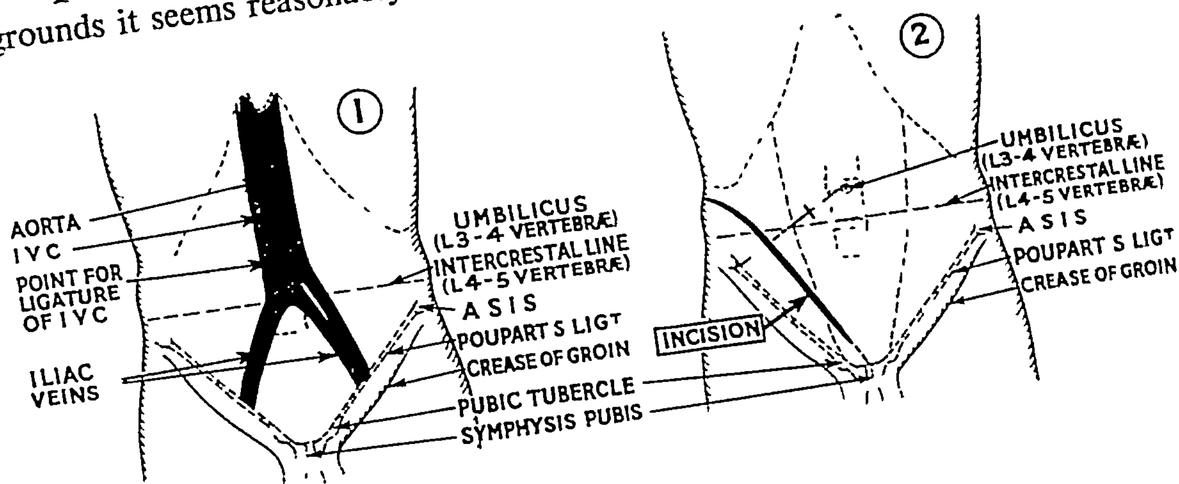
In spite of these drawbacks cases occur in which a major venous ligation appears to be the only way to stop the vicious circle of recurrent thrombosis and recurrent embolism and for this indication (if the other conservative measures have failed) it should undoubtedly be done. In patients in cardiac failure, such a ligature will also have a beneficial effect on the cardiac condition (Cloetens *et al* 1953) by cutting down the venous return

Ligation of inferior vena cava.—The vena cava is best approached by an oblique right lateral muscle cutting incision by the *extra* peritoneal route. The peritoneum is stripped up from the posterior abdominal wall until the cava is reached (the ureter adheres to the peritoneum) (Fig. 246)

Bilateral common iliac vein ligation.—This is the operation of choice the only disadvantage being that a trans-peritoneal approach is necessary The common iliac veins lie behind and deep to the common iliac arteries and are approached by a lower right or left paramedian incision. The bifurcation of the common iliac arteries is easily identified and the vein is tied immediately above this point, or it may be sought for in the angle formed by the internal and external iliac arteries Ligation here cuts off all chance of emboli from the pelvis and lower limbs just as effectively as caval ligation The great advantage is that the ligature is placed below the large ilio-lumbar veins which enter the common iliac veins near their union to form the vena cava. These ilio-lumbar veins form an important collateral for venous

return from the pelvis and lower extremities, and disabling swelling of the legs is much less (sometimes absent) after ligation at this site

Femoral vein ligation.—Cases occasionally occur in which on clinical grounds it seems reasonably certain that the source of the recurrent emboli is



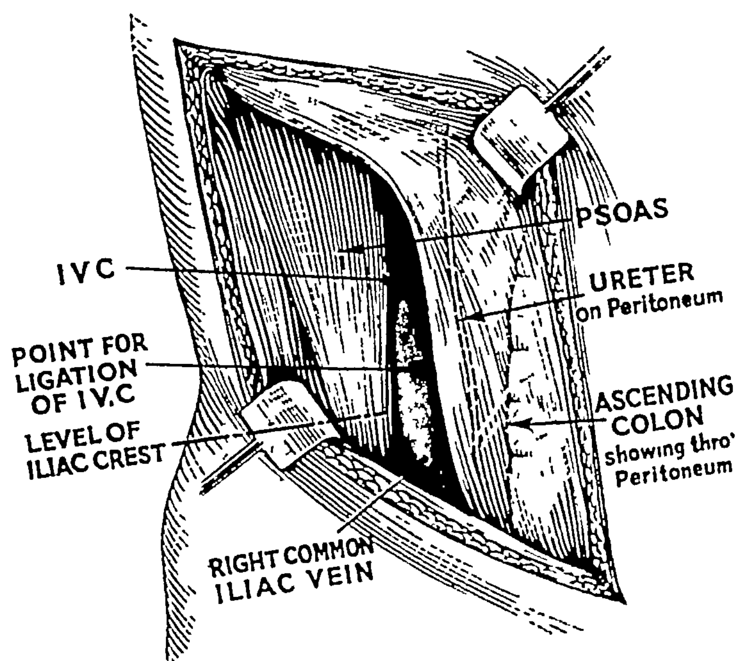


Fig 246

No 1—Depicting the surface anatomy of the inferior vena cava in relation to the abdominal wall No 2—The incision for the ligation of the inferior vena cava No 3—Illustrating the retro-peritoneal exposure

the leg In these it is possible to stop the recurrent embolism by a *bilateral* femoral vein ligation The femoral veins are exposed at their junction with the profunda, through a generous longitudinal incision in the line of the femoral artery If the profunda vein on exposure and palpation feels normal

and no thrombus is felt within it, a ligature is placed on the femoral vein *distal* to the profunda union This will effectively stop embolism from the lower legs, and has the additional great advantage of leaving little in the way of sequelae (Robinson and Moyer 1954) If the profunda vein shows evidence of involvement in thrombosis of course the ligature must be placed proximal to it on the common femoral vein This site of ligation always causes a some residual oedema in the limb however

As Carlotti *et al* showed even in cases of ligation of the femoral veins, a clot occasionally forms in the segment of vein proximal to the ligature, and emboli may occasionally occur from this source. However in spite of this in general it has been found that a well placed venous ligature will stop the recurrent embolic episodes in the majority of cases.

Thus venous ligation should not be resorted to unless adequate conservative measures have failed to control a situation of recurrent thrombosis and embolism. In cardiac patients and those in whom there is reason to suspect the pelvic veins as the source of thrombosis the ligature should be on either the vena cava or better on both common iliac veins In others, if on reasonable clinical grounds the source of emboli is thought to be the lower legs, *bilateral* femoral ligation may be done

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CHAPTER XIII

VENOGRAPHY OF THE LOWER LIMBS AND THE MEASUREMENT OF VENOUS PRESSURES

RADIOGRAPHS of the veins after injecting radio-opaque substances into them were first made by Berberich and Hirsch in 1923 using strontium bromide and by McPheeters and Rice in 1929 with lipiodol but the method was little if at all used until the advent of the various iodide solutions for intravenous urography In 1930 and 1931 Ratschow and Schwarz reported successful results with uroselectan and abrodil (Skiodan) as did Sgalitzer and Kollert in 1931 and Barber in 1932—but all these were direct injections into the superficial veins of the leg In 1934 Edwards and Biguria reported the use of diodone (Diodrast) which is sold under various proprietary names and which is the substance now generally used. In the same year Allen and Barker described venograms made after intra-arterial injection—*indirect venography* a method which has found small favour in the limbs.

It was not until 1938 that a method was described by dos Santos (Lisbon) for outlining the deep veins as well as the superficial by direct venous injection He made the insertions into the superficial veins behind the external malleolus the films being taken as the radio-opaque material ascended in the leg and thigh with an entirely free circulation—*ascending venography* Since then the value of a tourniquet above the ankle, to force the radio-opaque substances into the deep venous system has been shown and numerous full reports of the technique and results have been published (Dougherty and Homans, 1940 Bauer 1940 Hellsten 1942) but both the results and interpretations were variable (Bauer 1941) Moore (1949) described a method in which the diodone was made to ascend in the vein but in which the venous flow was arrested and in which the results appear to be constant and predictable

In 1941 Luke gave injections into the femoral vein and as the radio-opaque material descended radiographs of the thigh and leg were obtained, a method which has since been used by Bauer (1948) to try to decide in which cases he should ligate the popliteal vein—*descending venography*

Interpretation of venograms.—It is easy enough to interpret a venogram of a perfectly normal leg. But in a leg whose venous system has been disorganised by deep thrombus and subsequent canalisation or by the development of numerous varicosities the picture obtained may be confusing. A considerable literature has grown up about the various techniques of venography and it is now becoming clear what one might expect from this method and what its indications and limitations are.

When performing such an examination the operator must have clearly in his mind what he wants to show Does he particularly want to outline the femoral and popliteal veins to see whether they are present, normal, and valved ? Does he wish to show the presence of incompetent perforating veins in the lower leg ? Slight differences in technique are necessary for the two procedures

Indications for venography.—The research which has been done on venography has clarified much of the late pathology of deep thrombosis and varicose veins in general Now that much of this is understood, venography as a practical and helpful method of examination has only a limited place

In the practice of the authors its practical application is now limited to two groups of cases only (1) cases who have had a previous deep femoral thrombosis (white leg) who are suffering from gravitational aching pains in the lower leg, in whom the operation of deep venous ligation is contemplated

In such cases an ascending venogram (with the Valsalva manoeuvre) is very useful as it will show the presence or absence of a large valveless pathological deep channel

(2) Certain cases in which it is wished to demonstrate the presence or absence of incompetent perforating veins in the lower leg

(3) Cases in which a block of the common iliac vein or vena cava is suspected

ASCENDING VENOGRAPHY

General remarks.—The simplest type of venographic examination is the "ascending" type in which the contrast material is injected into a small vein on the dorsum of the foot, or ankle, and "ascends" the leg There are four major points of importance in performing these venograms —

1 THE POSITION OF THE PATIENT —The patient must have the legs down, by at least a five to ten degree tilt If the table is quite horizontal and the patient quite flat, or worse, with the legs very slightly raised, the speed of the venous return flow from the legs is much increased (*see* p 303) and the contrast material does not mix adequately with the blood, and does not stay long enough in the limb to give an adequate picture In such circumstances "streaming" effects (Fig 251A) are seen in the veins, and a patchy distribution of the dye, which in the past have been interpreted as "thrombi in the vein," or filling defects With the legs ten degrees down these artefacts seldom occur, and the mixing with the blood and filling of the veins by the contrast material is much better

2 THE AMOUNT OF CONTRAST MATERIAL —If adequate filling and visualisation of the deep veins is to be obtained a relatively large amount of contrast material must be used One of the authors (F B C) routinely uses 40 - 50 ml of 35 per cent diodone for this purpose, a more concentrated solution than 35 per cent is never necessary

3 THE USE OF A TOURNIQUET TO OBSTRUCT THE SUPERFICIAL VEINS OF THE LOWER LEG —In a normal leg, contrast material injected into a superficial vein of the foot will automatically find its way into the popliteal and femoral veins as this is the normal route of blood flow However when the venous system is pathological particularly in post-thrombotic cases with blocked or recanalised deep veins—a tourniquet is necessary to direct the bulk of the contrast material into the deep system. The position of the tourniquet—which should be a simple piece of rubber tubing—is important It must be

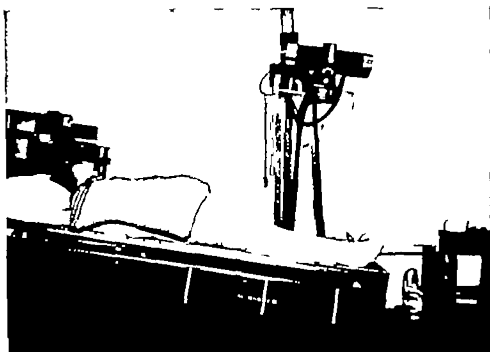


Fig. 247
The position of the patient for ascending venography (note the "legs down" position)

nearly half way up the leg and not too tight. This is to allow an adequate number of communicating veins below the tourniquet to function and conduct the contrast material inwards from the superficial veins If this is done, an injection into any vein on the dorsum of the foot will give a good picture of the deep veins.

If numerous large superficial varices are present they should be obliterated by a crêpe bandage otherwise contrast material tends to "spill over" into them and obscure the picture.

4 THE LEG MUST BE ELEVATED AND EXERCISED IMMEDIATELY AFTER THE PICTURE —Diodone even 35 per cent. diodone is irritating and if left in contact with the vein wall for long enough may *cause* thrombosis With the leg ten degrees down and motionless the contrast material tends to remain in the leg veins for a long time (up to ten minutes in some cases) Thus

immediately after performing the venogram, the legs should be elevated and exercised vigorously to empty the diodone out of them Neglect of this precaution may occasionally result in quite severe thrombosis of either deep or superficial veins

Techniques of ascending venography to show the deep veins (Femoral, popliteal and deep veins of the leg)

Ascending venography may be done either with a free circulation (Boyd, 1948, Cockett, 1953, Dow, 1951) or with the arterial inflow occluded by a sphygmomanometer cuff (Moore, 1949)

Many of the patients in whom one wishes for information on the deep veins have a foot which is either oedematous or has numerous minute veins on it—and there is often real difficulty in finding a vein big enough to take a needle Thus one may have to resort to either of the following procedures (1) *Cutting down* over the known position of the lower end of the saphenous vein (inner part of the dorsal venous arch), exposure of the vein, and cannulating it with a needle or piece of polythene tube (Fig 255) This is a minor procedure and necessary if walking venous pressures are to be measured as part of the procedure, *or* (2) *puncture of the bone* The external malleolus can be punctured by a strong needle which enters the marrow cavity of the fibula Injection straight into this cavity fills the veins of the lower extremity very well This technique has recently been described by Begg (1954) It might appear that there is a lurking danger of bone infection, if there is any skin infection nearby, or if there is any break in technique However, Begg has reported venograms by this method without any ill effect

Our experience with intra-osseous venograms has been very encouraging After a local anaesthetic has been injected right up against the periosteum, a sternal puncture needle can be pushed through the cortex without undue pain An injection made into the lower end of the fibula will fill the peroneal, posterior tibial, popliteal and femoral veins, in that order (Fig 248) An injection made just below the tuberosity of the tibia will fill the femoral vein An injection made into the great trochanter will fill the external, internal and common iliac veins and outline the lower part of the vena cava (*see* Fig 36) If the patient is in the erect position, dye injected into the greater trochanter will trickle down a valveless recanalised femoral vein, especially if helped by a Valsalva manoeuvre (thus performing a descending venogram by this method)

Whichever method of injecting the dye is used, the following is a reliable technique for showing up the deep veins :—

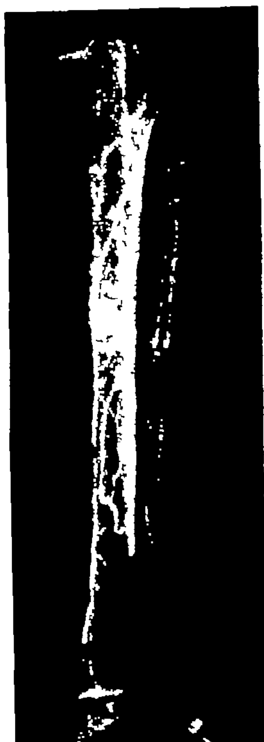
1 The patient lies flat on the table, which is tilted *down* at an angle of ten degrees

2. The needle or polythene tube is inserted in the chosen vein

3 The light rubber tubing tourniquet is applied round the lower half of the limb (not necessary with the intra-osseous injection)



A



B

Fig. 248
Intra-osseous venograms through the fibula malleolus. A—Normal veins. B—The leg of a man who had permanently obliterated deep veins.

4 Diodone, 40 - 50 ml of 35 per cent, is injected *steadily* and *quickly* into the vein (taking fifteen to twenty seconds to inject the whole)

5 A plate under the lower leg is exposed just before the end of the injection

6 This plate is rapidly removed, and at the same time a lead screen covering a second X-ray plate under the thigh and knee is removed This should take six to eight seconds only.

7 Exactly ten seconds after the first plate (the lower one) has been exposed, the patient does a forcible Valsalva manoeuvre (see below) and the thigh plate is exposed



FIG 249
Ascending Venography
A venogram of the deep vein of a young man suffering from mild superficial varicose veins The Valsalva technique was used, showing the valves well demonstrated (Compare this with Figure 38 in the Anatomy chapter)

Of course, if there are facilities for exposing the whole lower limb on one plate, the rapid change of films and two picture technique is unnecessary Also, if the leg is bent at the knee and laid *on its side* on the table, nearly all of the thigh and about half the leg can be shown on one plate—again making two pictures unnecessary (Fig 249)

The Valsalva manoeuvre consists of the patient taking a deep breath, closing the lips firmly, pinching the nose, and then attempting to blow out hard Its effect is as follows. The forced expiration with the glottis closed causes a rapid rise of venous pressure in the big veins of thorax and abdomen. This increased venous pressure spreads retrogradely down the inferior vena cava, and sends a reflux of blood down the limb veins, which causes their valves to open, and the contrast material is caught up in the valve pockets and gives an excellent picture of the valves (Figs. 249 and 40) Thus by the efficient use of this manoeuvre, the presence or absence of valves in the deep venous channels can be demonstrated—a most important point

Technique of ascending venography to show the ankle perforating veins. The satisfactory demonstration of these veins by venography is difficult. Their shortness and small size makes them very difficult to pick out on a film unless one knows exactly where to look for them However the following technique will often show them satisfactorily

1 A needle or polythene tube is inserted into a vein on the dorsum of the foot, or into the external malleolus—as already described

2. The patient is tilted into the *erect* position

3 Diodone 15 20 ml of 35 per cent. is injected *slowly* (taking nearly a minute over the injection in contrast to venography for the deep veins)

4 X-ray films behind the lower leg are exposed half a minute after the start of the injection and at one minute, immediately after the injection is finished

The pictures shown in Figure 259 were obtained by this technique



Fig. 250
Normal deep veins of leg, on ascending venography

DESCENDING VENOGRAPHY

Descending venography means that the contrast material is injected into the femoral vein at the groin with the patient erect, and allowed to *descend* the vein The method was used by Luke (1953) Bauer (1940) Moore (1949) and others to try and show whether valves were present or absent in the femoral and popliteal veins This was at one time considered to be of some importance in the aetiology of ulceration and induration of the lower leg and so a good deal of work has been done by this method

Descending venography may be done by a percutaneous puncture (Luke, 1953 Dow 1951) of the femoral vein with the patient lying on a tilting X-ray table which is angled with the feet down at forty-five degrees (1) The site for puncture is marked at a point immediately medial to the spot where the femoral artery pulsations are felt in the groin (2) After infiltration of the skin the needle is entered until venous blood is withdrawn easily (3) The femoral vein is then occluded *above* the site of needle puncture by thumb pressure against the ramus of the pubis, and 20 ml of 35 per cent. diodone is run gently into the vein (taking about ten seconds) (4) A film behind the thigh is exposed immediately the injection is finished.

This same investigation can also be done during the operation of high saphenous ligation, using the proximal divided end of the long saphenous vein as the point of entry for the dye, or by an intra-osseous injection into the greater trochanter of the femur



FIG 251

These venograms are of the same leg—that of a young man with mild uncomplicated superficial varicose veins
A Ascending venogram Patient flat no Valsalva No valves are seen and there is streaming of the dye in the upper third of the femoral vein B Descending venogram—same patient Twenty ml of 50 per cent diodone were injected into the stump of the great saphenous vein at operation (Patient tilted feet down, femoral vein occluded above the injection) Note—1 valves now shown 2 dye streaming down the vein past the valve cusps which are not quite shut at the time of making this exposure C Another descending venogram (same leg) made five minutes after B, but with slower injection and later exposure Note that in both B and C much dye has reached the popliteal fossa, yet there are normal valves in a normal deep vein

The interpretation of descending venograms.—Much confusion followed the publication of various reports on retrograde or descending venography in which the contrast medium was shown going down as far as the popliteal vein, or even farther, past apparently normal valves It was thought that by this technique one could distinguish " competent " from " incompetent " valves

(Bauer 1948 Lockhart Mummery and Hillyer Smitham 1951 Boyce, Detar and Vest, 1953) Further experience with this method and with the study of the movement of the valves under the fluoroscopy screen during the Valsalva manoeuvre (Gryspeerdt and Cockett, 1953 Dow 1953) has proved this view to be wrong. *The fact is that the dye can be demonstrated to flow down normal veins past normal valves in normal legs* This is shown conclusively in the three pictures constituting Figure 251 The degree of retrograde flow in normal veins in the erect position depends partly on the specific gravity of the contrast material (diodone is heavier than blood) but mostly on the speed and force of the retrograde injection and the exact timing of the film A forceful retrograde injection into the femoral vein will immediately open up the valve leaflets fully so that little or no contrast material descends into the leg A very slow injection of dye on the other hand will trickle down past normal valves to the lower leg



FIG. 252
A further example of a normal deep vein on descending venography
(M Moore)

Thus if valves can be demonstrated as *present* in any deep veins that vein and the valves are normal A vein can only be definitely labelled abnormal recanalised or valveless if *by a technique which ordinarily always shows the valves* (*i.e* either descending venography or ascending venography with the Valsalva technique) they are shown to be completely absent. Some examples of abnormal deep veins are seen in Figures 253 and 254 So when interpreting the pictures obtained by descending, or Valsalva ascending venography there are really only three possible interpretations. These are —

1 Valves present = deep veins normal

2. Valves absent and contour of veins irregular or multiple = recanalised thrombosis.

3 Deep vein absent and replaced by mass of collaterals.

As a *very rare* possible fourth interpretation we may mention the case of congenital *absence* of valves in the femoral and popliteal veins. This diagnosis should be made with caution as it is rare and the small veins—tributaries of the main veins—are always well valved even in these cases.

Descending venography is much more trying for the patient than the ascending method and as all the desired information about the presence or absence of valves can be obtained by the use of the Valsalva manoeuvre in



FIG 253
The ascending venogram (Valsalva technique) of a woman, aged 48, who had had a white leg fourteen years previously, and who presented with post-thrombotic induration and ulceration of the lower leg Note the abnormal appearance of the deep veins—no valves are seen The femoral vein was tied in Hunter's canal A cross section of it shows multiple channel canalisation of an old thrombosis Note that the channels appear as mere slits in the section, but in life these are large, thin-walled venous spaces

ascending venography this technique has largely replaced the others at St. Thomas s Hospital

Complications of venography —Venography if carried out in the proper manner and with the precautions mentioned above, is practically free of any complications

The most important complication is sensitivity or anaphylaxis to the contrast medium With the modern preparations (diodone, pyelosil) such reactions are rare With the older preparations reactions to the minute amount of free iodine they contained were not uncommon However it should be a rule that any patient who is to have a venogram (or arteriogram) should have a sensitivity test of the contrast medium before the actual event This can be made either by instilling two drops into the conjunctiva the day before the injection or by injecting intravenously a small pilot dose of ½ ml of the diodone about five to ten minutes before the actual procedure. A reaction may take the form of a feeling of nausea and coldness with rapidly spreading oedema of face and arms (with possibly oedema of the glottis threatening the airway) to a mild urticarial rash In any case adrenaline (1/1000) should be at hand always as these cases respond to a subcutaneous or intramuscular injection of a 5 10 minims (¼ 1/3 ml) of 1/1000 adrenaline if given early and promptly



FIG 254

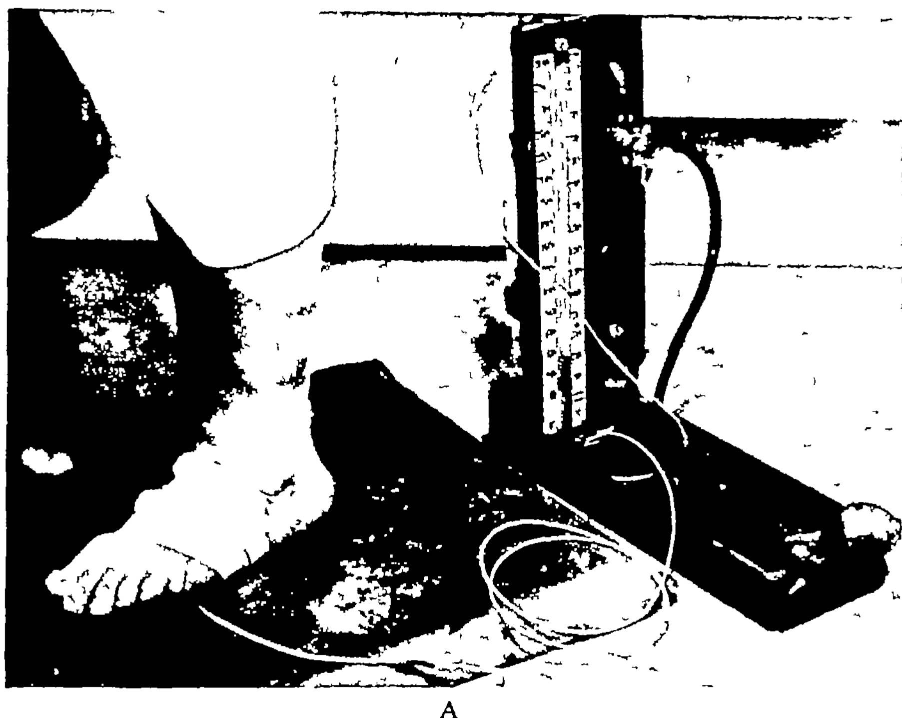
Ascending venogram, Valsalva technique, of a young man of 28 who had a chronic ulcer of the skin for six years. Note the irregular—"motheaten"—appearance of the femoral vein, without any normal valve cusps. A piece of this vein taken for section at operation showed it to be an old thrombosis. This is an example of valve destruction, leaving a large single channel

The complication of thrombosis and how to avoid it by immediate exercise afterwards has already been mentioned

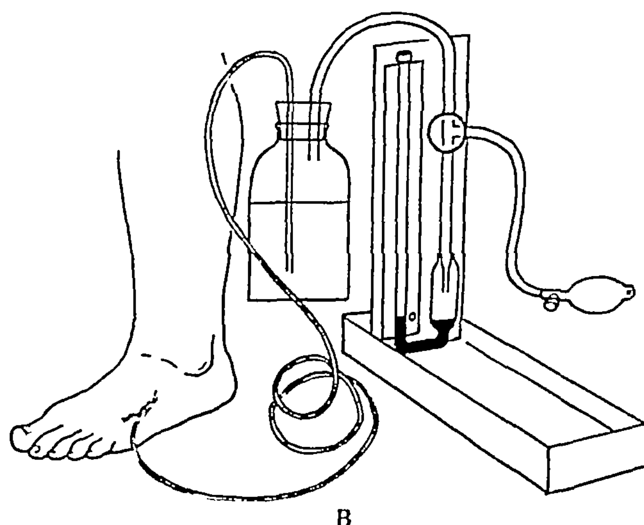
Most patients get a flushed face a slight sensation of nausea, and palpitations after the injection of diodone but these pass off rapidly and can scarcely be classified as complications.

Complications associated with the vein puncture haematoma and sepsis (in the case of cut-down wounds) should be rare if particular care is taken with the technique and to pressure-bandage the feet after the examination

The maximum dose of diodone.—Up to 80 ml of 35 per cent diodone can safely be used at any one injection Diodone in the more concentrated forms (50 per cent and 80 per cent) is irritating and should not be used for venograms



A



B

FIG 255 Photograph and explanatory diagram of the apparatus for venous pressure measurements

THE MEASUREMENT OF THE VENOUS PRESSURES IN THE SUPERFICIAL VEINS OF THE LEG AND FOOT

Measurements of the behaviour of the venous pressure in the superficial veins of the leg and foot at rest, and while walking or exercising, were a real advance in the understanding of the physiology of venous return from these

superficial tissues and in the basic pathology of venous ulcers These venous pressure measurements are reported in Chapter XIV

A brief description of a simple technique for measuring these venous pressures is given here. This method was described by Walker and Longland (1950) and it can easily be combined with a venographic examination in the same leg. The apparatus is shown in Figure 255

A polythene tube is inserted into a small vein on the dorsum of the foot by a cut-down under local analgesia It is then connected with the reservoir of heparinised or citrated saline as shown. This is really a positive pressure intravenous drip in which the positive pressure can be regulated by the converted sphygmomanometer

With the patient standing, the pressure in the reservoir is slowly lowered until blood just appears from the vein and proceeds along the polythene tube. The resting venous pressure is taken as the pressure at which a further advance of the blood meniscus along the tube is just retarded In the standing patient this pressure is between 80 90 mm Hg. according to the height of the individual

The person is then instructed to mark time smartly but without lifting the feet too far off the ground (and thereby dislocating the tube in the vein) and the same procedure of adjusting the pressure to keep the blood steady in the polythene tube is repeated while the patient is so moving. This is the " exercising venous pressure.

Venous pressures obtained in this way are probably not accurate to within more than 5 10 mm Hg. but this degree is sufficient for investigating the somewhat gross changes that occur in venous pressure A full discussion of the changes recorded in venous pressure in normal and pathological legs will be found in Chapter XIV

Again it is emphasised that this investigation has been mainly a research procedure and has been of supreme importance in illuminating this field It has not a great deal of use in routine clinical practice.

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CHAPTER XIV

THE PATHOLOGICAL PHYSIOLOGY OF VENOUS ULCERS AND THE POST THROMBOTIC SYNDROME OF THE LEG

FOR some time the lesions of the lower leg with which this chapter deals have been known as *varicose ulcers* This name has been responsible for many of the misconceptions in the pathology and treatment. For the fact is that although many patients with ulcers of the leg have varicose and incompetent superficial veins of the leg and thigh these are often *not* the main factor in the causation of ulcers. Within the last forty years it has become firmly established that the ulcer syndrome is more commonly due to post thrombotic disease of the deep veins and that varicose superficial veins do not necessarily play the major role.

The history of the growth of knowledge about these ulcers and their relation to disorders of the venous system was dealt with admirably by Anning (1952) and the following short summary is taken from this source

Hippocrates first noticed the association of varicose veins with leg ulcers (Hippocrates) However not until Harvey s discovery of the valves and the part they play in the circulation did further progress occur Wiseman (1676) writing about venous thrombosis dilatation of veins, and the results of these conditions on the valves seems to have been the first to consider that these ulcers might be due to a circulatory defect. As a result of the writings of many distinguished men of the late eighteenth and early nineteenth century (Home, 1801 Hodgson 1815 Brodie, 1846 Chapman 1853 Astley Cooper 1837 Hunt 1859 Hilton 1861 and Critchett 1848) the emphasis was placed on the varicose veins and the term varicose ulcer was adopted

However in 1867 an outstanding investigation on the aetiology of ulcers of the leg was published by Gay (1867-68) (*see* p 16) This work was the first painstaking scientific investigation of this condition in England. He pointed out, as did Nunn (1852) that severe long-standing varicosity may exist without ulceration—and that it is in fact the rule rather than the exception—a most important observation neglected until comparatively recent years (Lockhart Mummery and Smitham 1951) He noted that with ulcers there were other serious lesions of the deep veins and he wrote " Ulceration is not a direct consequence of varicosity but of other conditions of the venous system of which varicosity is not infrequently a complication " A most penetrating observation. He described the pathological condition of the deep veins in the post thrombotic leg, and he gave an accurate anatomical description of the ankle perforating veins. The term *venous ulcer* was first introduced by him

Since the time of Gay little advance was made until Homans (1917) presented his study of the pathology of thrombosis of the deep veins of the leg and showed that re-canalisation with destruction of valves was probably very common after deep thrombosis, and that ulcers of the leg followed and were closely related to this deep venous pathology.



FIG 256
John Homans, born 2nd September, 1877, died 7th June, 1954, Professor of Surgery, Harvard Medical School

The introduction of venography by Dos Santos (1938), and the study of venous pressures in the veins of the leg and foot at rest and exercise, have added a great deal to our knowledge of the normal physiology of venous return from the leg, and the effects of thrombotic disease on this Finally, a re-study of the venous anatomy of the leg, in conjunction with the foregoing, has made it possible to build up a clear picture of the pathology of venous ulcers and the post-thrombotic syndrome

Clinical evidence of the association of past deep thrombosis of the leg veins with ulcers and induration.—During the last ten years, analyses of the number of patients attending vascular clinics for ulcer of the leg, and the proportion giving a history of previous deep thrombosis, have appeared

These figures have all demonstrated the importance of the previous history of thrombosis in the ulcer syndrome They are given in the table below —

Author	*No of cases of ulcer*	*Percentage giving a definite history of previous thrombosis*
Bauer 1952	38	87 per cent.
Birger 1947	432	40 per cent.
Nilzen, 1945		41 to 56 per cent
Anning, 1952	715	80 per cent.
Dodd, 1954	121	30 per cent.

The extreme variability of these figures must be expected, for there are two variable factors in compiling such series — 1 The criteria as to what constitutes a history of deep thrombosis may vary widely among even well qualified observers and also among the patients themselves. 2. The type of clinic from which these statistics are compiled. Thus Anning s very high figure comes from a skin clinic and cases with obvious varicose veins may not have been referred to it.

However from these figures it would appear that in approximately forty to fifty per cent. (at least) of the patients complaining of ulcerated leg, a previous history of deep vein thrombosis can be obtained.

Another and more fruitful line of clinical research was pursued by Bauer (1942) and Hojensgard (1952) These authors followed up over a number of years a group of patients known to have had deep thrombosis in the past from their hospital records Bauer s findings are given in the following table —

No of years after thrombosis	*Percentage of cases with induration of the lower leg*	*Percentage of cases with actual ulcers*
5	45 per cent.	20 per cent
10	72 per cent.	52 per cent.
later	91 per cent	79 per cent.

Hojensgard (1952) published the results of a follow-up study of eighty nine unselected extremities from fifty seven patients in which deep thrombosis had occurred from six to thirty-one years previously No fewer than eighty nine per cent. of these legs had developed serious sequelae Eighty-seven per cent. had heaviness and fatigue seventy-eight per cent. had chronic oedema twenty seven per cent. had present or past ulcer and forty-five per cent. had to wear a supporting bandage all the time

These figures are impressive showing that within five years of occurrence of deep thrombosis of the leg, about half the patients have developed indurative lesions in the gaiter area with or without actual ulceration As time goes on this proportion gets higher These figures also call

attention to the time factor, which was also stressed by Homans *Between two and five years after a deep thrombosis* is the peak time for the appearance of ulcer and induration In a series of twenty patients with a definite previous history of post-partum white leg studied at St Thomas's Hospital (Cockett, 1953), ten (fifty per cent) first noticed the ankle lesions two to two-and-a-half years after the deep thrombosis

Thus, from these clinical studies, there is indisputable evidence of the great importance of previous deep thrombosis in the ulcer and induration syndrome of the lower leg

The relation of ulcers to varicose veins.—In the St Thomas's Hospital ulcer clinic, the problem was attacked in a slightly different way Here the uncomplicated varicose veins, and the ulcers of the leg were seen on different days, and the contrast between those patients with gross varicose veins and no ulcer (seen in the vein clinic) and those with ulcer but minimal or absent varicose veins (seen in the ulcer clinic) was noticeable During the year 1952, 740 new cases of varicose veins without ulcer were seen in the varicose vein clinic, and ninety-six new cases of ulcer of the leg (of which eighty-three were venous ulcers) were seen in the ulcer clinic

A statistical survey of the ulcers of venous origin over the years 1951 and 1952 was made from the point of view of whether a previous history of thrombosis was present, and whether incompetent varicose veins were present In order to eliminate the inconsistencies of the statistical surveys mentioned above, very strict criteria of previous thrombosis were maintained The patients were found to fall into three fairly well defined groups —

	1951	*1952*	*Total*	
Group 1 Ulcers with obvious incompetence of superficial veins No definite history of thrombosis	53	44	97	=53 per cent
Group 2 Ulcers with a definite preceding history of femoral thrombosis or white leg	27	11	38	=22 per cent
Group 3 Ulcers with no demonstrable incompetence of superficial veins and no definite preceding history of thrombosis	27	20	47	=26 per cent
			182	

The criteria for this grouping is illustrated in Figure 257 and was as follows —



FIG. 257

The three legs depicted here are the three major clinical types of venous ulcer

1 Group 1 A chronic ulcer with obvious and grossly incompetent veins of the great saphenous system.

2. Group 2. A chronic ulcer with no superficial veins visible on the leg. This woman gave a clear history of a deep femoral thrombosis or "white leg" two years before her ulcer appeared.

3 Group 3 A chronic ulcer in a young man. He had no incompetent superficial varicose veins. He denied all history of previous thrombosis Note that all three ulcers occupy the same position. An incompetent ankle perforating vein was found at operation in all three apparently different types of ulcer

GROUP 1. These patients had a palpable cough impulse in the great saphenous system, which was usually dilated, with varices below the knee A few had incompetence of the small saphenous system only.

GROUP 2 These were patients who gave a definite history of previous white leg or femoral thrombosis, with swelling of the whole leg from ankle to groin—usually entailing a stay in the hospital of three to five weeks. Such an occurrence is not easily forgotten by the patients and so the history is definite and reliable

GROUP 3 These patients had no incompetent veins judged by Group 1 criteria Some of them had small superficial varices in the lower third of the leg, but they did not appear to be connected to an incompetent great or small saphenous system They did not give a history of deep thrombosis as judged by Group 2 criteria However, some of them had a suggestive history of calf thrombosis (an episode of tenderness of the calf and transient swelling of the ankle) , many denied any such history

This group of ulcers (Group 3) has been the cause of much confusion, and it will be seen that they accounted for twenty-six per cent of the whole series

Less than one-fifth of the patients in Group 2 had incompetent superficial veins Usually no varicose veins were to be seen on the surface of the leg at all A few of the patients in Group 1 also gave a suggestive history of minor calf thrombosis

Thus in this series a little less than forty-eight per cent of the ulcers seen had no incompetent superficial varicose veins of the great or small saphenous system

In addition to the above a group of eleven cases whose ulcer had recurred after an apparently adequate high saphenous ligation operation were seen during 1952

The state of the main deep veins in Groups 1, 2 and 3 as shown by venography.—The condition of the large deep veins in these groups was then determined by the Valsalva technique of ascending venography (Gryspeerdt and Cockett, 1953) This was of great interest, as it has been claimed that recanalisation and destruction of valves in the main popliteal and femoral veins is the main factor in the aetiology of ulceration of the leg (Bauer, 1942)

The findings in these cases were that in Group 2 the majority of cases had complete recanalisation and destruction of valves in the whole popliteal and femoral systems In groups 1 and 3, however, (patients who had exactly similar ulcers) the valves in the popliteal and femoral veins were present and normal *These findings tend to show that valve destruction in the large veins (popliteal and femoral) has very little to do, per se, with development of induration and ulceration in the lower leg We propose to show that these lesions are due to a local valve destruction in the ankle perforating veins*

The venographic findings in a group of thirty-three patients who gave a clear history of having had a white leg or femoral thrombosis previously were of interest. In twenty nine of these cases, complete recanalisation of the deep venous system from ankle to groin was demonstrated conclusively. In nine of them this was further demonstrated by biopsy of the deep vein obtained during the operation of femoral or popliteal ligation. Thus there was clear evidence of complete recanalisation in eighty-seven per cent. of the cases.

In two patients we were able to demonstrate complete recanalisation twenty and twenty-four months respectively after the occurrence of a white leg

Complete recanalisation is not an *invariable* occurrence, however. We have found a fibrous cord at operation occupying the situation of the femoral vein in three patients who had previously had a femoral thrombosis

Thus it would appear that effective recanalisation of a thrombosed deep venous system occurs in the vast majority of cases and takes between one and two years.



FIG. 258

Eighteen months previous to this picture this patient had a normal leg. At this time he was admitted to hospital with a saphenous thrombophlebitis. This is the only case we have seen in which this thrombus spread to the deep vein, giving rise to pulmonary emboli. His common femoral vein was ligated. Following this he developed a retrograde deep thrombosis (proved venographically). After the swelling had subsided, at his follow-up visits, the gradual appearance of the "ankle flare" of dilated veins and pigmentation in the area shown was seen to appear. One year after the deep thrombosis an enlarged upper internal ankle perforating vein could be felt. He has been on continuous treatment with a firm webbing elastic bandage which has prevented him from developing an ulcer so far. If ulceration threatens he will have this perforating vein ligated.

The situation of venous ulcers.—Homans (1938) writing on post-phlebitic ulcers, noted that there was little specific about them and that they tended to occupy the same part of the leg as the so-called varicose ulcers. Looking again at Figure 257 it is striking that the situation occupied by and the appearance of all these ulcers of apparently different venous pathology is the same. Hanschell (1949) stated "The great majority of patients with varicose veins, at all ages have and have had no leg ulcers while the great majority of patients with leg ulcers, at all ages have and have had no varicose veins yet in its clinical features, under all conditions, there is no discernible difference between ulcer with and ulcer without varicose veins."

Turning back to the section on anatomy it will be appreciated that the lower leg and ankle the gaiter area is the area which is



Fig. 259

The pathology of post-thrombotic induration and ulceration of the ankle (A and C —early B and D—late) A and C are the venogram and photograph of the ankle of a patient who had a deep thrombosis one and a half years previously She now complained of an indurated, red, scaly area well shown in the photograph, which ached and was painful after being on her feet No veins were visible or palpable. The venogram revealed the large incompetent perforating vein. Notice particularly the fine venular dilatation in the subcutaneous tissues—leading down from the perforating vein. B and D are the venogram and photograph of a patient who had her deep thrombosis twelve years previously This is the fully developed post thrombotic syndrome of the ankle with ulcer and induration. Once again the venogram reveals the incompetent perforating vein—and the fine spray of dilated venules arising from this and permeating the su ... sues of the ulcer area. (The operation on this leg is illust ... 34)

pump mechanism is impaired and this is shown by the fact that the fall of venous pressure in the subcutaneous veins on exercise is less than normal, or does not fall at all (Fig. 1)

Several fairly extensive studies of these venous pressure changes have been made, notably by Smirk (1936), Pollack and Wood (1949), Pollack, Taylor, Myers and Wood (1949), Walker and Longland (1950), DeCamp, Ward and Ochsner (1951), Warren, White and Belcher (1949), and Hojensgard and Sturup (1949 and 1952). The basic behaviour of the venous pressure in the superficial veins of the leg in cases of pure incompetence of superficial veins, in post-phlebitic legs, and in the normal have been established by these authors

There have been several differences in technique used by them Pollack and Wood used the saphenous vein itself in front of the internal malleolus, Warren, White and Belcher used " a branch of the saphenous vein in the calf" (their illustration shows one high up the calf being used), DeCamp, Ward and Ochsner used a vein of " foot or lower leg ", Walker and Longland used a vein of the dorsum of the foot These facts are mentioned because the particular vein chosen for the pressure recording may have a bearing on the result Warren, White and Belcher particularly mention this point, and even show different exercise falls of venous pressure in different veins from the same limb

However, there has been basic agreement on the following facts —

(1) In normal legs, with the patient erect, the venous pressure in the subcutaneous veins of foot and ankle falls rapidly on exercise to between 0 and 30 mm Hg , and then rises *slowly* (31 seconds according to Pollack and Wood) on cessation of exercise to its previous height of 90 mm Hg

(2) In patients with primary incompetent superficial varicose veins, the pressure falls to a value of 45 - 60 mm Hg , rising *rapidly* (within three seconds) to the initial figure of 90 mm Hg on cessation of exercise

(3) In post-phlebitic cases there appears to be some variation. Most authors find that there is either no fall of pressure on exercise, or a slight fall—to a value of 75 or 80 mm Hg with an immediate return to the pre-exercise level on cessation of exercise DeCamp *et al* actually recorded a slight rise in pressure on exercise in four cases

	Standing pressure	*Exercise pressure*	*Time of return to standing pressure*
Normal superficial veins	90 mm Hg	0 - 30 mm Hg	31 seconds
Primary varicose veins	90 mm Hg	45 - 60 mm Hg	3 seconds
Post-phlebitics	90 mm Hg	75 - 90 mm Hg	Immediate

sustained local venous hypertension can in fact cause ulceration onclusively in Figure 261 The patient shown here had a traumatic ous fistula between a branch of the subclavian artery and vein in lavicular fossa This had led to widespread local venous dilatation ension in the subcutaneous tissues of the shoulder Eventually a



FIG. 261

ulcer" of the shoulder This patient had arterio-venous fistula between a branch lavian artery and vei the left supra gion. His arm n lost at the rl ury t further treat velop large shallow oulde oked just lik sure dressin of the leg

lder rsisted until ulce leg due to

e is connection s ar ecting the

pressure on contraction of rectus femoris was 18 mm. Hg In the lower third of the soleus the rise of pressure on contraction was 90 mm Hg, and the contraction pressure fell gradually to between 30 and 40 mm Hg. as the needle was put in higher and higher in the calf Thus there is unequivocal evidence from this work that on contraction of the calf there is a considerable rise of pressure within it, particularly in the lower third.

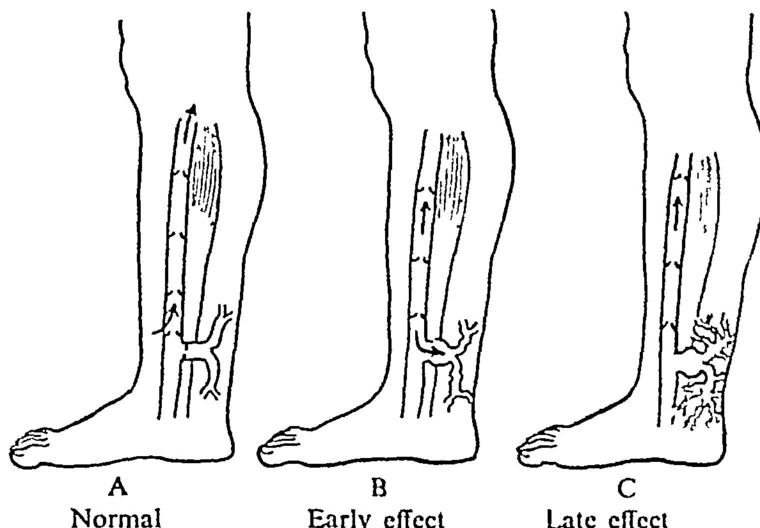


FIG 260
Diagram to illustrate the effects of destruction of the valve in the ankle perforating veins Via these short wide veins if their valve was rendered incompetent, the great rise of pressure in the deep veins of the leg on every calf contraction could be transmitted straight out to the delicate venous mesh with which they are connected The result of this would be a gradual dilatation of all the small venules in this area a condition which is seen frequently as a pre-ulcer phenomenon and occurs under every established venous ulcer

Turning now to Figure 260, it will be seen that the effect of incompetence or destruction of the valves in one or more of the direct ankle perforating veins will be to transmit the high exercise venous pressure within the lower third of the calf during contraction of the soleus, directly to the mesh of fine subcutaneous venules in the gaiter area This will lead to their gradual dilatation (Fig 259C) including the small subcuticular venules (Figs. 267 and 268) This localised increase of superficial venous pressure on exercise is " drained away " to some extent into the deep veins of the foot via the " ankle flare " (Figs 258 and 277) Moreover, this localised high venous pressure and dilatation is occurring over an area of remarkably slight arterial supply. The effect on the subcutaneous tissues and skin of the area is to impair their nutrition very considerably, with the production of local swelling and tissue necrosis. This is the essential and basic pathology of venous ulcers and induration of the ankle The process is slowly progressive over the years, and the type, situation, and severity of the lesions in the gaiter area vary according to the chronological stage of the venous dilatation as well as to a number of other factors.

That sustained local venous hypertension can in fact cause ulceration is shown conclusively in Figure 261 The patient shown here had a traumatic arterio-venous fistula between a branch of the subclavian artery and vein in the supraclavicular fossa This had led to widespread local venous dilatation and hypertension in the subcutaneous tissues of the shoulder Eventually a



FIG. 261

A "venous ulcer" of the shoulder This patient had a traumatic arterio-venous fistula between a branch of the subclavian artery and vein in the left supra clavicular region. *His arm had been lost at the time of the original injury* He sought further treat ment because of the development of a large shallow surface ulcer of the shoulder This looked just like a venous ulcer and responded to pressure dressings in exactly the same way as venous ulcers of the leg do

large chronic venous ulcer appeared over the shoulder which persisted until the fistula was closed (*See also* Chapter XV on ulcers of the leg due to congenital arterio-venous fistulae.)

Now from Figure 262 it will be seen that there is a direct connection between the great saphenous vein and the fine venous arches connecting the

internal ankle perforating veins by means of the posterior arch vein (Leonardo's vein) arising from the great saphenous vein at knee level. Thus in great saphenous incompetence the high venous pressure transmitted down this vein may eventually reach the ankle perforator area But if the ankle perforators are competent, this high venous pressure will be "sucked off" into the deep veins of the muscle pump Varicose veins of the great saphenous system must therefore be of considerable size, before they exert an appreciable effect on the venous mesh in the gaiter area *However*, if there should be an incompetent ankle perforator *and* incompetence of the great saphenous vein, the addition of these two sources of increased venous pressure takes place in the gaiter area with progressive local effect. This is the usual pathology of "varicose ulcer" (*see* p 347) Exactly the same remarks hold true for incompetence of the small saphenous vein and incompetence of the lateral ankle perforating veins, except that in this case the maximum effect tends to be on the outer side of the ankle (Fig 263).

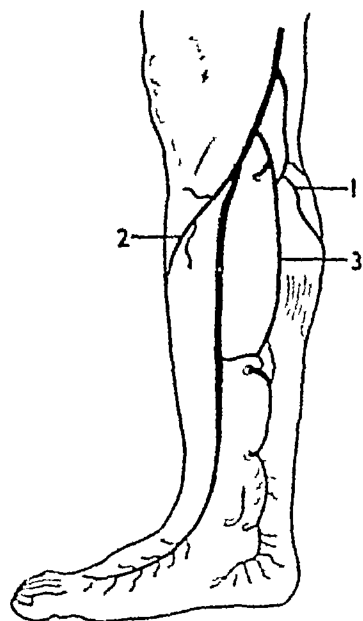


FIG 262

Diagram of main perforating veins of the leg. The figures refer to the three groups of branches which usually arise at knee level (*see* Anatomy chapter) The vein marked 3 is the large constant posterior ankle vein which descends to anastomose with the ankle perforators

One further point is of importance The direct ankle perforating veins are quite large veins. When they become incompetent and dilate their size is considerably increased. It is not uncommon to find a dilated ankle perforator half a centimetre in diameter in the vicinity of a venous ulcer This factor of relative size is very important, as the degree to which venous pressure effects can be transmitted without "damping" increases very rapidly with vessel size A short wide vessel such as these incompetent ankle perforators become is ideal for transmitting venous pressure variations

How the valves in the ankle perforating veins are destroyed.—It is our experience that by far the commonest way in which the valves of the perforating veins are destroyed is by thrombosis One of the commonest varieties of thrombosis, as we have seen (Chap. XII) is calf thrombosis This starts in the large venous sinuses in soleus and then spreads via the numerous veins draining soleus into the posterior tibial venae comites and thence upwards for a greater or shorter distance Now reference to Figure 45 and Figure 46 in the anatomy chapter will show that if clot spreads down the lower two veins draining soleus it has a direct path of spread outwards along the upper and middle ankle perforating veins This has been seen to occur at post-mortem dissection several times by us There is also clinical evidence for this In an early case of calf thrombosis the sign of tenderness in the lower

calf may be elicited if the fingers are then moved gently up and down the line of emergence of the ankle perforators often the site of either the upper perforator or the middle one will be found to be exquisitely tender This early sign of calf thrombosis has also been commented upon by Cohen (1952) During the subsequent months this clot recanalises Then not only is the segment of deep vein formerly occupied by this clot rendered valveless and incompetent, *but the perforating vein also* It takes between one and two years for effective recanalisation of deep veins to take place. Thus the lesions only begin to appear one to two years after the original episode of thrombosis

Not only the upper two inner ankle perforating veins but also the external ankle perforating veins may be rendered incompetent in this way

An analysis of which of the ankle perforators are most frequently found incompetent at operation.—At operation it is possible to tell whether the valve in a perforating vein is competent or not by a simple and definite test which was first described by Turner Warwick (1931) When a normal perforating vein is cut across at operation the end which is left disappearing through the hole in the deep fascia to connect with the deep vein does not bleed. This is because its valve at the junction with the deep vein is held shut by the venous pressure in the deep vein This can be shown if a probe is gently inserted down the lumen of the perforator and the valve held aside. Bleeding immediately occurs Now if an *incompetent* perforating vein is cut across, the result is very different—profuse steady bleeding occurs outwards from the deep vein. Moreover if the calf is suddenly squeezed opposite the incompetent perforator a jet of blood is ejected from it with surprising force. This is a practical demonstration of what happens in normal circumstances when the calf pump is put into action This test is known as the "bleed-back or Turner Warwick s test.

During 1952 and 1953 ankle perforator exploration was done on 135 limbs with early and late indurative lesions and ulcers of the ankle (at St. Thomas s Hospital) This group of cases *did not* have incompetent superficial veins of the great saphenous system Incompetent ankle perforating veins were found proved incompetent by Turner Warwick s test and tied in ninety-six of these cases The veins found incompetent in this series are shown in the following table —

Ninety-six patients

Upper internal ankle perforator incompetent only	24
Middle internal ankle perforator incompetent only	55
Both internal ankle perforators incompetent	4
Lower internal ankle perforators incompetent	0
Lateral ankle perforator incompetent only	12
Anomalous origin of small saphenous perforating low down in calf	1
	96

23A

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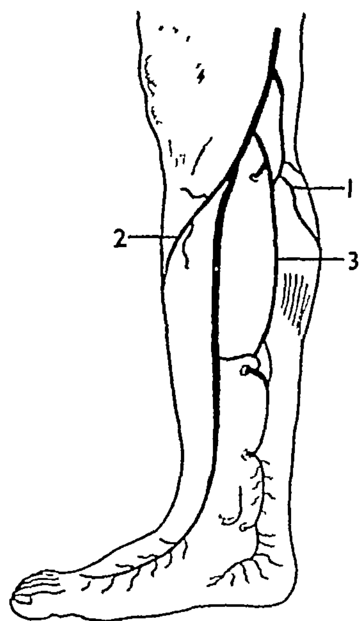


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Lateral ankle perforator incompetent only	12
Anomalous origin of small saphenous perforating low down in calf	1
	96

This series of cases was most instructive, showing which perforating veins were most likely to be found incompetent in such cases Three significant facts emerged —

1 Either the middle or the upper internal ankle perforator is most likely to be incompetent It is unusual for both to be found to be incompetent in the same leg. This may be related to the anatomical fact already noted that they tend to vary inversely in size Thus when the upper one is large the middle one is small and vice versa

2 The lower ankle perforating vein located just below and posterior to the internal malleolus is hardly ever found to be incompetent

3 The lateral ankle perforator was found incompetent in just over twelve per cent of the cases and the possibility of this vein being at fault *even when most of the pathology is on the inner side of the leg* must be kept in mind. By means of a vein passing behind the tendo-Achillis (Fig 263B) the effects of incompetence of this lateral perforator may be distributed to the internal surface of the ankle as well as the external surface

During the same period, fifty-four cases *with* obvious incompetence of the great saphenous system and indurative lesions of the lower leg of varying degrees of severity were also operated upon These cases had a routine high saphenous ligation, often a stripping of the great saphenous vein, and an exploration of the ankle perforators The findings in this group were —

Fifty-four patients with incompetent veins of the great saphenous system and a lower leg ulcer

Cases in which no incompetent perforator in the lower leg could be demonstrated	18
Cases in which either the upper (eight cases) or the middle (twenty-eight cases) ankle perforators were found incompetent .	36
	54

Thus, from these figures it would appear that in approximately sixty-six per cent of cases with varicose veins and a lesion in the lower leg, *an incompetent ankle perforating vein is also present*, and is contributory to the lower leg lesion It was noticeable that those with the most severe lesions always had an incompetent perforating vein as well *This is the reason why so many varicose ulcers recur after an efficient operation on the great saphenous system. The incompetent perforator near the ulcer is left behind and perpetuates the ulcer-forming process as soon as normal activity is resumed*

The association of short saphenous incompetence and lateral perforator incompetence.—Turning to Figure 263, it will be seen that the lateral ankle perforating vein usually joins either the main trunk or a large branch of the small saphenous vein in the lower third of the leg (*see also* Chap III). Incompetence and dilatation of the small saphenous system is rarer than that of the great saphenous system, and it is more difficult to diagnose The

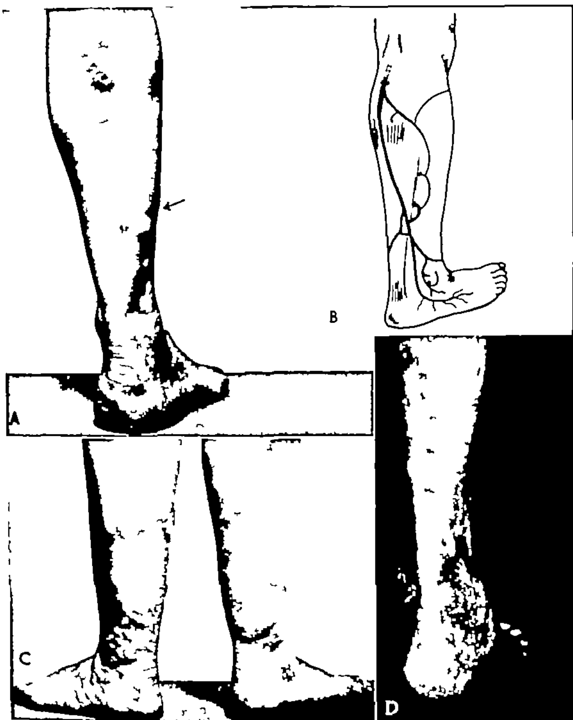


FIG 263

Early and late cases of short saphenous with lateral perforator incompetence. A—Early case of short saphenous incompetence Shows enlarged short saphenous, large lateral perforator (arrow) and early skin changes behind lateral malleolus. B—Diagram of the usual anatomy of the short saphenous vein and the lateral ankle perforator C—Short saphenous incompetence in a fat leg. There is an eczematous skin reaction down the back of both ankles, and a bunch of dilated veins around the *lateral* malleolus. The short saphenous itself can neither be seen nor palpated through the fat. D—Advanced ulceration *behind* both malleoli, due to short, saphenous and lateral perforator incompetence.

main area affected by small saphenous incompetence is the skin area below and behind the lateral malleolus (Fig 263). However, so common are the anatomical variations, and particularly so common is the venous connection with the arch connecting the *internal* ankle perforators (Fig 262), that in over half the cases skin lesions appear behind the internal malleolus also In a few cases they appear predominantly here (Fig 257, 3)

The small saphenous vein, being a relatively shorter vein and with fewer tributaries than the great saphenous, valvular incompetence or destruction at its union with the popliteal vein allows the high ambulatory venous pressure here to be transmitted down to the ankle region relatively easily Ankle lesions—venular dilatation, eczema, swelling and ulceration tend to be a much more common accompaniment and appear earlier with incompetence of the short saphenous vein If the lateral ankle perforating vein is competent this acts as a safety valve constantly "sucking off" the accumulating high venous pressure at the lower end of the small saphenous vein If this lateral perforating vein is incompetent it adds its quota of high venous pressure at every contraction of the calf to that in lower part of the small saphenous drainage area This combination (small saphenous incompetence and lateral perforator incompetence) has been found to be the cause of severe eczema or ulceration behind both malleoli on about fifteen occasions so far, and appears to be a highly destructive combination, comparable in every way with the combination of great saphenous incompetence and internal perforator incompetence

The factor of different tissue response to venous stress.—The main channels through which a local raised venous pressure may be brought to bear on the capillaries and tissues around the malleoli have been discussed But this is only half the story in the pathology of these indurative and ulcerative lesions around the ankle Anyone seeing a large number of patients with venous lesions in various stages of evolution cannot fail to be impressed by the fact that the tissues of different patients react in very different ways to a given degree of venous stress Thus the hairy, well nourished, average male ankle with relatively little subcutaneous tissue will show a considerable degree of venular dilatation before any surface ulceration becomes apparent and even then it may only be slight (Fig 278) At the other end of the scale is the fat, hairless, erythrocyanoid type of female ankle. Here nutrition of the large amount of fatty subcutaneous tissues is poor and the addition of an increased local raised venous pressure may precipitate another tissue necrosing reaction This consists of a relatively sudden *massive fat necrosis* of the subcutaneous tissues Figure 259c shows the clinical appearance of such a case Dusky, red, indurated, painful areas appear in the subcutaneous tissues of the gaiter area, as shown Venography shows it infiltrated by dilated venules, usually arising from an incompetent ankle perforator. This acute lesion may do one of two things (1) it



FIG. 264

Purpuric Reactions.

A.—Purpuric reactions of the skin over an incompetent great saphenous vein in a young man. This disappeared after a high saphenous ligation. B.—Ecchymosis of the whole lower third of the legs in a senile patient—the so-called "senile purpura." Patients with Cushing's syndrome often develop a similar reaction in the skin of the area. The skin is very poor and may break down forming numerous ulcers as in C. C.—The senile purpuric ulcers.

may slowly resolve on rest and supportive treatment leaving an indurated plaque in the gaiter area which is always liable to ulcerate; or (2) it may rapidly break down and ulcerate In this case a chronic, ischaemic looking ulcer with blue edges is formed, which being an ischaemic lesion, is intensely painful—particularly at night when the limb gets warm. This type of ulcer may take months to heal even under skilled care

Every variation between these two extremes of reaction may be seen

Another interesting reaction of the skin and subcutaneous tissue to local venous stress is the occurrence of purpura or ecchymosis Certain patients seem to react particularly in this way, as shown in Figure 264. Senile patients, particularly, may react to even the increased venous pressure occasioned by long standing, by the development of a purpuric rash or ecchymosis around the ankle. These sometimes break down and form ulcers This "senile purpura" (so called) is unassociated with any demonstrable blood abnormality, although it may be associated with chronic undernutrition and Vitamin C deficiency, and it is always worth while treating these patients with ascorbic acid This is one of the important factors in many senile ulcers

The histology of venous induration and ulceration.—To appreciate the histological abnormality seen in sections of these lesions it is necessary to be aware of the arrangement of the minute venous drainage and arterial supply of the skin of the area This is shown diagrammatically in Figures 265 - 272 and is of great interest, and we are indebted to Dr Whimster for permission to publish his work here for the first time

It will be seen that immediately below the epidermis there is a sub-papillary venous plexus, which sends tufts of capillaries into the interpapillary spaces This subpapillary venous plexus is drained by a number of small veins into the larger veins which lie deep in the subcutaneous tissues In the dermis these collecting veins anastomose freely, but as they pass through the layer of subcutaneous fat they receive a small number of veins, each one of which drains its own area *of fatty subcutaneous tissue* and is an end vein (that is to say, it does *not* anastomose with other venules draining adjacent fat lobules) Thus if one of these veins is thrombosed, or if flow from it is hindered by local venous hypertension, the result can only be swelling and eventual necrosis of the lobule of fat drained by it. This is the essential pathology of the acute fat necrosis seen so often in fat ankles with venous lesions The effect of the local rise of venous pressure on the subpapillary venous plexus and venules in the dermis is to cause dilatation of the plexus over the affected area and dilatation of the capillary tufts These changes are shown in Figures 267 and 268

The lymphatics in venous ulceration.—It might seem reasonable to suspect that the deep lymphatic trunks are involved in the pathology of the post-phlebitic syndrome It is conceivable that they might be obliterated or compressed by the periphlebitic inflammatory reaction round the deep veins

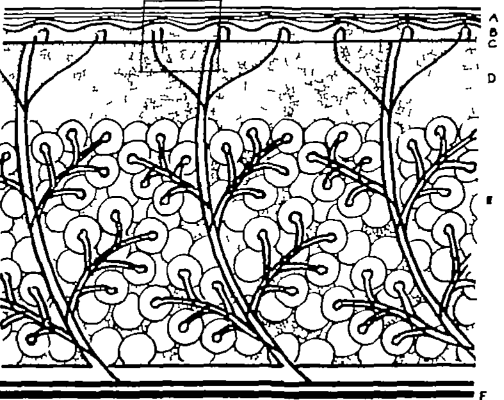


Fig 265



Fig. 266

Fig 265 Diagram to illustrate the difference in mode of blood supply between the superficial layer of the dermis and the deeper layers of the dermis and subcutaneous fat. It is not intended to be an accurate representation of the vessels concerned but simply to show the difference between the venous drainage of the two capillary beds. The superficial layer is supplied by a capillary bed draining into a horizontal reticular venous plexus, which is in turn drained by vertical veins connecting with the main veins running deep in the subcutaneous fat and in the plane of the deep fascia. The capillary bed supplying the deeper layers of the dermis and the fat do not drain into a plexus but into lobular veins which run directly into the vertical veins. The sub-epidermal venous plexus and its capillary bed act as an escape valve for general rises in venous pressure in the skin and a diffuser of local ones, by distension of the plexus and proliferation of the capillary bed. The lobular vascular supply of the deeper layers has not this ability to expand and if venous pressure rises severely in this field due to spasm or thrombosis, circulation ceases and necrosis occurs. (A—epidermis B—superficial zone of dermis, C—sub-epidermal venous plexus D—deep zone of dermis E—fat, F—deep fascia.)

Fig. 266 Section through the full depth of the skin of a normal leg (The dark band running across the upper part of the fat layer is a large vein)



FIG. 271
Capillary bed proliferation in the edge of a venous ulcer
A—Epidermis.
B—Superficial zone of dermis.



FIG. 272
Capillary proliferation in the floor of a venous ulcer

In the same way it is possible that in the neighbourhood of a chronic ulcer the subcutaneous lymphatics might be involved by the inflammatory reaction

Kinmonth (1952 and 1954) has investigated this possibility Using the dye " patent blue " injected into the sole of the foot, he showed that this permeated up the deep lymphatic trunks These trunks could then be seen at operations in the popliteal and femoral regions, and the rate of transmission of the dye along them estimated These appeared quite normal in eight out of ten advanced post-phlebitic cases investigated His conclusion was that in the post-phlebitic cases studied the deep lymphatics were normal There is as yet no data on the state of the local lymphatics round an ulcer

One of the great characteristics of the swollen leg of "lymphoedema" is the *absence* of skin lesions and ulcers, and the above finding therefore fits in with what we know clinically

The secondary effects of induration and ulceration of the ankle on the mechanics of the foot.

1 TOURNIQUET EFFECT—The gradual necrosis of the subcutaneous tissues followed by induration and fibrosis of the gaiter area may progress to such an extent that the whole of the gaiter area is encased in a sort of tight fibrous tourniquet This appearance has been aptly described clinically as " beer bottle " or " champagne bottle " legs, according to the taste of the particular writer This fibrous tourniquet, once formed, further obstructs venous return and contributes in no small measure to the oedema of the ankle and foot beneath it, and in these cases gross oedema of the foot and ankle may be a serious problem Moreover, if ulceration occurs in this area in these cases, a profuse exudation of serum occurs, which sometimes soaks the dressings The protein loss from these areas may be considerable in such advanced cases, and we have seen one such case in which considerable lowering of the serum protein concentration occurred from this cause The skin over these widespread sclerotic plaques is precarious and any knock or scratch may set off rapidly spreading surface ulceration It is in this type of leg that the large, irregular, shallow and often circumferential ulcers tend to occur

2 SHORTENING OF THE TENDO-ACHILLIS AND SECONDARY EFFECTS ON THE MECHANICS OF THE FOOT—In a small proportion of cases a contracture of the calf muscles takes place during the active painful phase of ulceration, leaving the patient with a foot in marked equinus This contracture tends to occur especially in those women with the erythrocyanoid type of limb in which the ulcer is very painful The ankle is held immobile in the equinus position, as this is the position of maximum comfort

When the ulcer heals or gets less painful, the contracture may persist and the patient is left with an equinus foot This equinus deformity may be such that the patient can only walk normally in high-heeled shoes, being quite

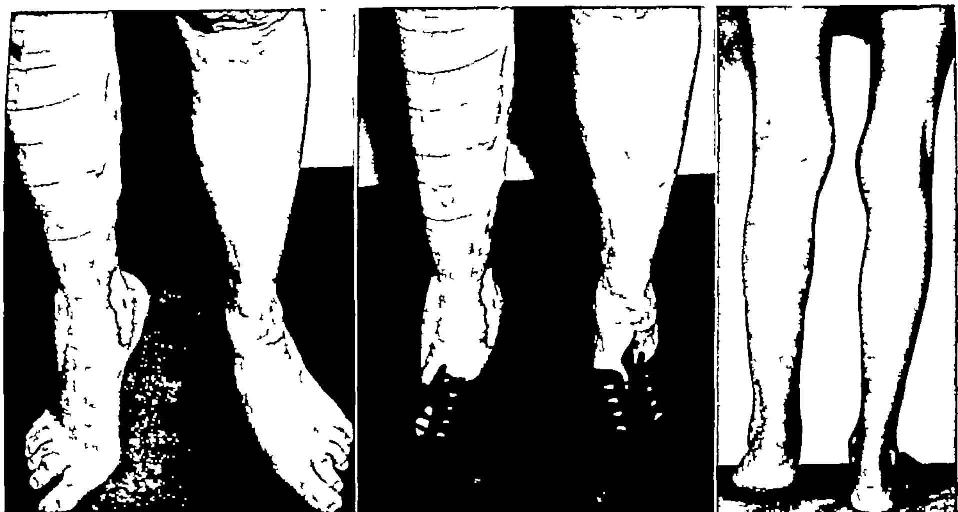


FIG. 273

Equinus heel deformity

A —This patient with a small chronic venous ulcer could not get her heel to the ground. B —She was quite comfortable in a high heeled shoe C —Another example of the equinus deformity in a chronic venous ulcer

unable to get the heel to the ground (Fig 273) Minor degrees of the deformity are quite common in post-phlebitic cases

This disability soon brings into being a whole train of secondary deformities in the foot The intrinsic muscles of the foot atrophy and contract and gradually the picture of pes cavus with claw toes and hallux valgus develops Figure 274 is an illustration of this established deformity in an old case of post-phlebitic ulceration



FIG 274

The secondary effects on the mechanics of the foot, caused by ulceration, and shortening of the tendo-Achillis The slight pes cavus, claw toes and short tendo-Achillis on the ulcerated leg are in marked contrast to the normal foot on the other side

It is essential to correct this equinus deformity at an early stage to prevent complete deterioration of the foot In most cases of relatively slight shortening of the tendo-Achillis, adequate treatment to the ulcer, plus exercises under the supervision of a masseuse, and insistence of wearing low-heeled shoes will be enough to overcome the deformity Where gross shortening of the tendo-Achillis has taken place, operative lengthening of the tendon by a subcutaneous tenotomy technique may be necessary This shortening of the

tendo-Achillis further reduces the efficiency of the calf pump which is another reason why it must be corrected at the earliest possible moment in these cases

Other components of the post phlebitic syndrome.—Patients who have had a past history of white leg or deep thrombosis in addition to the ulcer or induration of the gaiter area, tend to develop three other clinical symptoms These are (1) oedema (2) generalised aching pain in the lower leg, and (3) a hypertrophy of the calf muscles, associated with cramps.

OEDEMA —Patients with pure incompetence of the superficial veins do *not* as a rule tend to develop oedema of the leg and ankle (except when the tendency to swelling is already there as in the erythrocyanoid legs) In patients with deep venous incompetence oedema of the ankle is usually a prominent feature Its degree varies considerably In those who have merely localised destruction of the valves in the calf veins and one or more perforating veins, the oedema may be minimal In patients who have complete post thrombotic destruction of the valves in the femoral popliteal and calf veins it may be a major complaint It is usually controllable by elastic bandages or stout elastic stockings

GENERALISED ACHING PAINS IN THE LEG AND CALF —This is the symptom which Bauer drew attention to and called bursting pain True bursting pain in the calf is more commonly a symptom of acute calf thrombosis than of the post-phlebitic state in our experience Patients with complete valve destruction in the femoral and popliteal system however do sometimes complain of a generalised aching of the whole of the lower leg towards the end of the day *This generalised aching of the leg must be carefully distinguished from pain in and around the ulcer area which is a much more common complaint* It is particularly noticeable in those who have to work on their feet all day—the busy housewife being the typical example. It is often noticeable that although elastic bandaging of the limb may control the oedema and the ulceration it fails to control this heavy aching pain. *This is the only symptom which is directly attributable to large valveless femoral and popliteal channels and which may benefit from a femoral or popliteal vein ligation*

HYPERTROPHY OF THE CALF —An athletic looking hypertrophy of the calf is sometimes present in these patients It is due to chronic intramuscular oedema and is usually associated with the symptom of generalised aching at the end of the day or after a period on the feet, and with calf cramps. This again is a symptom of either an incompetent or permanently obliterated popliteal and femoral vein

Summary—The root cause of the induration and ulceration syndrome of the lower leg is the destruction of the valves in the ankle perforating veins This valve destruction is brought about by thrombosis which usually starts in the venous sinuses in the lower part of the soleus, spreading by the muscular

veins draining soleus into the posterior tibial vein, and so into the ankle perforating veins The organisation and recanalisation of this clot destroys the valves of the ankle perforating veins This allows the high venous pressure which normally occurs within the calf on exercise to be transmitted straight out to the subcutaneous tissues drained by these perforating veins The effect of this is to cause venular dilatation over the whole of this area The reaction of the tissues to this localised, high venous pressure varies considerably, but the usual result is subcutaneous fat necrosis and subsequent organisation with the formation of a hard plaque, which may or may not ulcerate Ulceration is usually precipitated by trauma or infection

Further destruction of valves in the popliteal and femoral veins is not essential for the development of induration ulceration In fact over two-thirds of those with venous ulcers can be shown to have normal femoral and popliteal veins Where the thrombotic process *has* involved the popliteal and femoral veins, and recanalisation with valve destruction has taken place (which is the usual but not invariable occurrence) this further embarrasses the venous return from the limb and is responsible for the persistent swelling and sometimes the heavy aching pain felt in such limbs after a long period in the erect position

The role of incompetence of the great or small saphenous systems in the production of ulcers and induration of the ankle is relatively unimportant although they add their quota to the "venous burden" on the ulcer area However, when the superficial venous incompetence is gross and of long duration it may cause lesions in the gaiter area on its own account Severe ulcers which are apparently due to superficial varicose veins are almost always associated with an incompetent ankle perforating vein as well In some of these cases it is possible that the valve in the perforating vein may have been destroyed by a thrombosis originating in a superficial varicose vein and spreading inwards

Finally, there is a group of cases, particularly in very old people, in which there is no definite point of valvular incompetence in the limb, but the sustained high venous pressure around the ankles, due to general immobility, age and lack of use of the calf muscle pump (for various reasons) causes venular dilatation and purpuric lesions around the ankle which may lead to induration, pigmentation, eczema and even ulceration

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CHAPTER XV

THE DIFFERENTIAL DIAGNOSIS OF ULCERS OF THE LEG AND ANKLE

IN this book a detailed consideration of lesions of the toes, forepart of the foot, and sole of the foot is not undertaken. Ulcers and lesions of these regions are almost never caused by venous pathology. The reason for this is probably best stated in Gay's own words. In his Lettsomian Lectures of 1867 he said "The veins of the foot anastomose so freely, and such are the

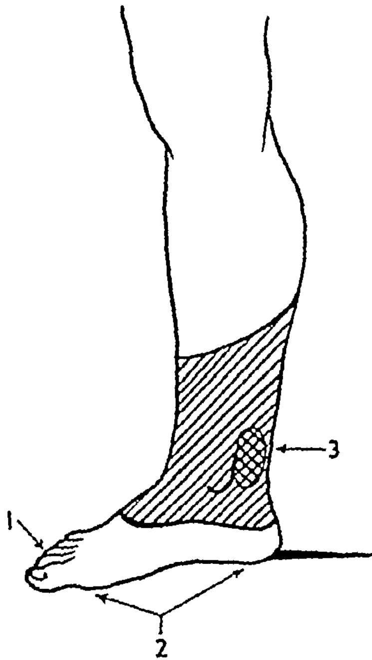


FIG 275

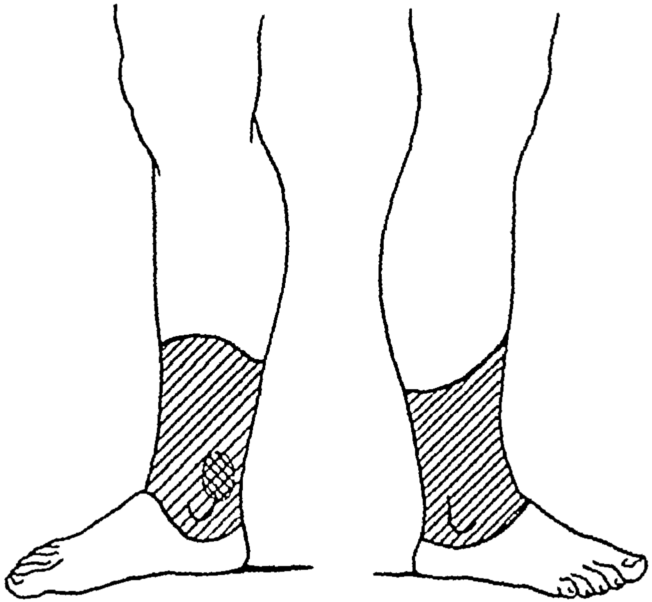


FIG 276

FIG 275—Diagram of the main causes of ulcer of the toes, foot and ankle. 1 *Chronic sores or ulcers of toes* are due to (*a*) Peripheral arterial disease (arteriosclerosis, diabetes, Buerger's disease, (*b*) Chilblains, (*c*) Chronic fungus infection, (*d*) Trauma and bone infection

2 *Ulcers of sole of foot* are due to (*a*) Nerve lesions, Tabes dorsalis, peripheral neuritis (diabetes), sciatic nerve lesion, (*b*) Peripheral arterial disease

3 *Gaiter area*, over which venous ulcers occur

FIG 276—The Gaiter Area. Venous ulcers occur anywhere within this area, but the place where most of them start is shown cross-hatched

means of escape for its blood, through either the deep or superficial system, that embarrassment to its venous circulation is hardly possible. It is not so however with regard to the superficial veins of the leg between the ankle and calf. In this part of the limb the venous circulation is exposed to greater difficulty and risk of obstruction than in any other part of the limb, if not in any other part of the body." To this might be added the fact that the

sole and toes of the foot have a profuse arterial supply as compared with that of the skin and subcutaneous tissues of the ankle as has been seen in the section on anatomy (Chap III p 63)

Ulcers and lesions of the foot are usually associated with pathology of either the arterial or the nervous system or are due to the various fungus diseases and other diseases which affect the skin of the toes and feet. These factors are summarised in Figure 275 and need not further detain us

VENOUS ULCERS

Of the ulcers of the leg and ankle those due to pathology of the venous system form by far the greater part. These ulcers have had various names in the past—varicose ulcers, gravitational ulcers post phlebitic ulcers—but in this book the term originally suggested by Gay for them venous ulcers will be used Such ulcers occur over the area of the leg shown in the diagram called appropriately the gaiter area" (Fig. 276) It will be noted that this gaiter area extends below and behind both the malleoli and very nearly half-way up the legs. Ulcers of purely venous origin are rare outside this region. Moreover although most venous ulcers start in the small area cross-hatched on Figure 276 above and behind the internal malleolus they *may* occur anywhere in this area, both on the outside and the inside of the leg.

Although venous ulcers are by far the commonest here a number of other types of ulcers occur on the leg and many of them encroach on this gaiter area and so the problem of differential diagnosis is a real one. In the St Thomas's Hospital Ulcer Clinic during the years 1951 and 1952, 234 new cases of ulcer of the leg were sent up under the diagnosis of venous ulcer Of these approximately thirty-one, or nearly thirteen per cent. had no connection with pathology of the venous system This is a high figure in a clinic which was at that time especially for so-called varicose ulcers and the figure would certainly be higher in a general clinic or in a skin clinic

Clinical characteristics of venous ulcers.—Venous ulcers occur twice as frequently in women as in men Some authorities claim that they have a predilection for the left leg. *Their most important diagnostic point is their occurrence within the gaiter area*

They are not necessarily associated with the presence of visible varicose veins. About half of them have no demonstrable incompetence of the great or small saphenous systems. Modern opinion inclines to the view that most of these ulcers are related more to disease of the deep than the superficial veins (Chapter XIV)

When considering the appearance of a venous ulcer it must be remembered that one is looking at one particular stage of a very chronic disease, and the manifestations in the gaiter area in the early years are less severe and widespread than after the disease has been present for twenty years or more Moreover these manifestations their speed of onset, symptoms and

signs vary considerably from patient to patient according to the form and type of leg which is the subject of the disease Thus the well developed warm, hairy leg of the average male is far more resistant to ulceration than the adipose, smooth skinned, hairless, cold leg possessed by some men and many women

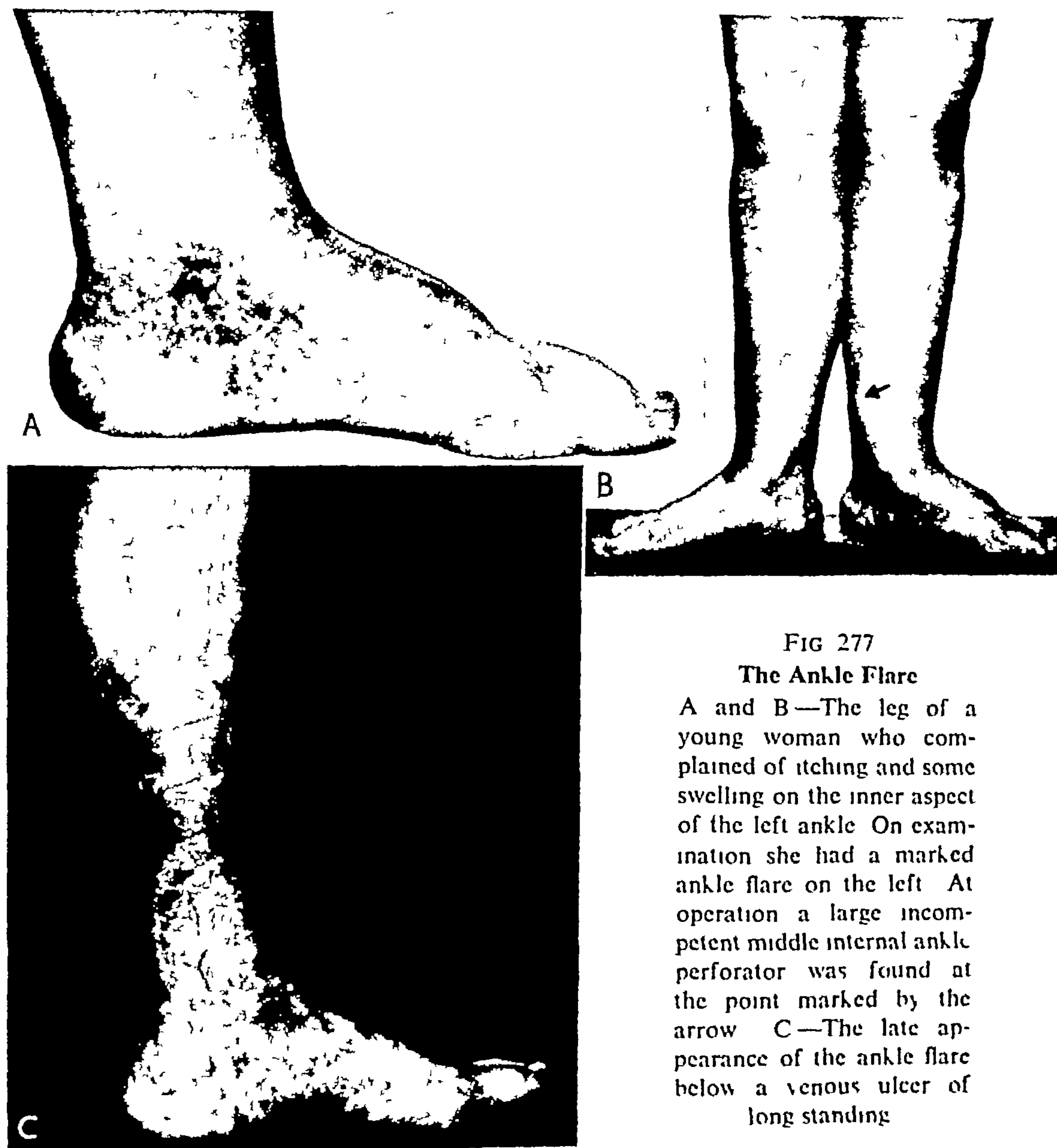


FIG 277
The Ankle Flare
A and B—The leg of a young woman who complained of itching and some swelling on the inner aspect of the left ankle On examination she had a marked ankle flare on the left At operation a large incompetent middle internal ankle perforator was found at the point marked by the arrow C—The late appearance of the ankle flare below a venous ulcer of long standing

Bearing these variations in mind there are certain signs and symptoms which are characteristic of venous ulcers These are:—

1 SITUATION Within the gaiter area, with a predilection for the site above and behind the internal malleolus

2 ASSOCIATION WITH VISIBLE SIGNS OF VENOUS PATHOLOGY—THE ANKLE FLARE. The most constant sign of venous pathology associated with ulcers is a flare of small subcutaneous dilated venules seen with the patient standing up and occupying the area immediately below and behind the internal malleolus. This is shown in Figure 277 There is often a similar flare below and behind the external malleolus as well when the ulcer may be situated on the outer side of the leg. This characteristic " ankle flare is a sign which occurs before actual ulceration takes place and may then be observed over the whole of the inner side of the ankle (Fig. 278) Once ulceration and



FIG. 278
Pre-ulcerous venular dilatation around the ankle.

its attendant infection and oedema has occurred the swelling and fibrosis of the subcutaneous tissues often obliterates this sign except in the area just above the heel pad (Fig. 277) In legs which are fat or oedematous this sign is not well marked as the subcutaneous fat tends to cover the dilated venules.

This " ankle flare " may be the only visible sign that the ulcer is indeed venous in origin there being few or no visible superficial varicose veins in the limb More usually however there are signs of obvious venous pathology in the limb—varying from a few so-called superficial varices above the ulcer region to complete and obvious incompetence and varicosity of the great or small saphenous systems or both

(3) ASSOCIATION WITH ECZEMA. Although any ulcer of the leg may be associated with eczema, venous ulcers are particularly prone to this associa

tion The whole of the skin of the ulcer-bearing area may react by a dry, scaly, itching dermatitis This is particulary so in those who already have a constitutional tendency to eczema or skin disease When, however, actual ulceration has taken place, the skin around the ulcer is always precarious and tends to react by an exudative eczema in the early stages *Local sepsis and the application of local medicaments (particularly penicillin creams, flavine, or sulpha drug creams) are the important precipitating causes for this eczema* Once present, unless controlled early, it may become violent and widespread in the leg It may even " generalise," the patient then appearing in a miserable state, with eruptions on the face, body and arms

4 PIGMENTATION Pigmentation is the sign which is typical of a long standing venous pathology in the gaiter area Its degree varies from case to case, but it is particularly noticeable in the older patients Considerable pigmentation may occur without ulceration, although more usually it is associated with old ulcers It is dark brown and is due to the deposition of haemosiderin in the subcutaneous tissues, derived from the breakdown of extravasated blood

5 INDURATION In certain cases with and without ulcer, the whole or part of the gaiter area becomes indurated That is to say, the subcutaneous tissues instead of being of normal thickness and soft, and the skin being freely mobile over the deep fascia, the whole skin, subcutaneous tissue and deep fascia become welded into a firm, solid mass and contracts This change is usually maximal above and behind the internal malleolus, but it may spread throughout the gaiter area The larger erythrocyanoid type of leg, and those with a lot of fatty subcutaneous tissue tend particularly to develop this change The contraction of the fibrous tissue may in time give the appearance of a tight constricting band round the ankle region with a tourniquet effect These legs have been graphically described as " inverted champagne bottle " legs which is a very true description of their clinical appearance The skin over the indurated area is in a precarious state of nutrition and any infected surface trauma tends to spread widely forming a vast shallow ulcer, which may become circumferential

6 OEDEMA Venous ulcers are usually associated with some degree of oedema of the ankle and foot This oedema is in fact an integral part of the post-phlebitic syndrome It varies considerably according to the extent of the post-phlebitic destruction of the valves in the deep and perforating veins, and according to the type of leg Where there is merely destruction of valves in one perforating vein and minimal destruction of deep vein valves, the oedema may be minimal or absent Increase in oedema round the ulcer is also seen as a result of acute infection

7 PAIN Pain is a variable symptom At one end of the scale are the small acute necrotic-looking ulcers which typically occur in the erythro-

cyanoid type of leg of women in which severe unremitting pain is the presenting symptom At the other end are the large chronic ulcers which may have been present for years, some of which appear to be completely painless

Clinically there are three relevant points in regard to the pain of ulcers —

(*a*) Acutely infected ulcers are very painful and most of the pain is relieved by controlling the acute infection

(*b*) Pain is usually prominent in the ischaemic leg (due to arterial disease) and the erythrocyanoid leg. In these the pain has the qualities of ischaemic pain that is to say it is usually better when the limb is dependant or moving and is bad at night when the limb is up and warm under the bedclothes (rest pain) These patients often get extremely ill and depressed through lack of sleep

(*c*) Pain is usually worse during the early stages of ulceration As the ulcer becomes more chronic pain tends to become less prominent as a symptom Most ulcers are painful to some degree depending on the mentality of the patient it is a congested burning sort of pain, not very severe In contradistinction to group (*b*) above it is usually relieved by rest with the foot up or by tight bandaging.

These then are the main clinical characteristics of *venous ulcers*

Next, the other ulcers which may occur on the leg which are not directly associated with venous disease must be considered

NON VENOUS ULCERATION OF THE LEG

Ulcers associated with erythrocyanosis frigida.—Lynn (1954) states " Chilblains, the pernio syndrome, dermatitis hiemalis, erythrocyanosis frigida nodular vasculitis, erythema induratum and Bazin s disease are all terms which have been applied to various stages in the progress of a single disease entity There is no reason to retain more than the simplest of these many terms.

Erythrocyanosis frigida or the pernio syndrome are the names of choice for a clinical condition of the legs and ankles seen almost exclusively in women and usually young women. The ankles are swollen and bulbous and lose their normal contour The skin is hairless and in cold weather has a chronic mottled blue tinge which is maximal to the outer side and posterior aspect of the ankle. This becomes bright red and painful on warming. In the subcutaneous fat of this region many small painful hard areas may develop These are actually patches of fat necrosis and the skin over them may ulcerate These ulcers occur usually either on the back of the ankle or to the outer side and are typically multiple. These patients often suffer from chilblains on the toes as well

Boyd (1950) has pointed out that these cases are merely severe examples of a common type of leg, which he has termed the erythrocyanoid limb This

A

B



FIG 279
Erythrocyanosis Frigida.
Three examples of the necrotic and ulcerative lesions which occur typically over the back, or external surface of these limbs

type of limb is seen frequently in women It is characterised by its smooth hairless skin a tendency to cyanosis round the ankle and chronic oedema even in the absence of any other pathology In general the severity of these symptoms is greater with increasing thickness of subcutaneous fat (the so-called erythrocyanoid lipoidaemia) One of the basic defects in these limbs appears to be that the arteries are of small calibre and the arteriolar supply of the thick fatty subcutaneous tissues is not quite adequate This leads to an anoxia in the subcutaneous tissues, with chronic anoxic dilatation of the skin capillaries and oedema The whole pathology is greatly accentuated by cold causing vaso-constriction of the superficial arterioles and further diminution of an already inadequate blood supply to the subcutaneous tissues Thus it is usually exposure to cold which precipitates the development of the fat necrosis, ulcers and chilblains All these symptoms are better in summer except the oedema which tends to be a little worse in hot weather These patients are usually very conscious of their legs and often have other annoying associated symptoms such as nocturnal cramps in the calf and a chronic irritation of the skin of the legs Figure 279 shows the typical appearance of the erythrocyanoid limb and the ulcers associated with it.

The next important point is that this type of limb stands up to the stress of any sort of venous incompetence badly Superficial varicose veins cause more distressing symptoms than in a more normal limb Venous ulcers round the ankle occur more easily are more painful and need all the resources and ingenuity of the surgeon to cure them Moreover the diagnosis of venous pathology is extremely difficult in these limbs as large incompetent veins may be so completely hidden in the thick subcutaneous fat as to be invisible and often impalpable Thus in these people the early diagnosis and treatment of any venous incompetence superficial or deep is of great importance if chronic and painful sequelae are to be avoided

The treatment of the erythrocyanoid leg and its complications may be considered under the following headings —

1 GENERAL MANAGEMENT The patients are warned not to expose the leg and toes to extremes of temperature In winter thick stockings or over-socks and warm ankle boots must be worn If the patient is very obese a weight-reducing diet will bring some relief

2. *Venous incompetence* should be carefully looked for and treated early by adequate operation

3 OEDEMA. If there is any venous incompetence in the limb this symptom is always ameliorated by appropriate surgery However in most cases the oedema is not associated with venous incompetence and is best treated by firm support with a webbing-elastic bandage or stout elastic stocking

4 ULCERS If recurrent ulceration of the calf tends to occur every winter then lumbar sympathectomy is indicated and in this connection it gives good

results The ulcers heal rapidly and pain is relieved, and the patient is grateful for the warm limb However, it is necessary to warn the patient not to relax the general precautions, because although the immediate results of sympathectomy are good there is a tendency to relapse after a period of about two years Even so, the ulcers are never so bad, nor so difficult to control, as before sympathectomy This operation has no effect on the oedema. In fact in the immediate post-operative period (up to two months), during the phase of maximal increase of blood flow, the oedema may be much worse, and the patient may be alarmed This temporary increase in oedema always settles gradually to what it was before operation



FIG 280
The Post-poliomyelitic Ulcer
The lesions on the wasted leg of a patient who had had poliomyelitis These are similar in every way to the lesions of erythrocyanosis frigida

Even when the ulcers are primarily of venous origin, and the appropriate surgery on the venous system has been carried out, sympathectomy may then be of benefit in consolidating healing However, a sympathectomy will not maintain healing in ulcers of primarily venous origin unless the appropriate surgery for the defective veins is carried out at the same time

Post-poliomyelitic ulcers.—A leg which has become partly or wholly paralysed as a result of old anterior poliomyelitis (or indeed any other nervous disorder, such as spina bifida) tends to undergo certain changes The muscles waste and contractures may occur, there is an increased tendency for the deposition of subcutaneous fat in the leg, and owing to its reduced activity the blood flow through it becomes much reduced The net result of these factors is the cold, blue limb, which approximates closely to the erythrocyanoid leg (Fig 280), and is subject to the same complication, *i e* the development of small painful chronic ulcers in the lower third, which are worse in cold weather The pathology of these ulcers is exactly the same as that of the ulcers in erythrocyanosis, namely areas of subcutaneous fat necrosis, with a surrounding inflammatory reaction, over which the skin gradually breaks down

The treatment of this complication follows the same lines as erythrocyanosis When conservative management fails to control them, lumbar

sympathectomy will produce great improvement, although as in the erythrocyanoid persons minor relapse in the later years must be expected and guarded against.

In early cases of threatened breakdown of skin over the indurated patches in the legs of both erythrocyanoid and post poliomyelitic patients—the stage of so-called "erythema induration"—ulceration may sometimes be arrested and the local symptoms relieved by the local application of "Trafuril cream" rubbed in three or four times a day. This cream which contains histamine promotes a local vaso-dilatation which lasts for an hour or two. It is very useful in the local management of such legs, both before and after sympathectomy and also is of great use in aborting chilblains. The limb should also be protected by an elastic stocking.

Traumatic and infective ulcers.—Any infected abrasion, or insect bite will take longer to heal when it occurs in the leg or ankle than in the arm or upper part of the body unless the patient is at rest. If in addition, the limb is of the erythrocyanoid type or the seat of venous incompetence or of arterial ischaemia the resultant ulcer may become very chronic.

However under certain conditions chronic ulcers may occur in normal legs. Examples of these were the so-called "desert sores" of the last war. These occurred frequently on the legs, following either a bite or some small abrasion and the reason for their persistence was chronic inadequately treated infection and repeated trauma inseparable from the conditions of life on active service. Men were unwilling to report sick for an apparently minor complaint, and so the ulcers tended to persist, get bigger and more obvious. They responded to treatment by simple antiseptics, rest, and dressings. Similar chronic sores may be seen in the legs of the poorer classes in most middle eastern countries.

Occasionally such ulcers become infected with a virulent organism such as the streptococcus, staphylococcus aureus or even the diphtheria bacillus. In such cases local pain and ulceration increase and the patient may become ill with raised temperature. In cases which became infected with KLB during the last war the dangerous diphtheritic toxaemia made its appearance and the patients were prostrated with a high pulse rate and diphtheritic paralysis if the anti-serum was not given.

The commonest traumatic ulcer seen in England in peace time is that of the shin or "footballers ulcer." This occurs in healthy young men who have received a "crack on the shin" during a game of football. The resultant sore is allowed to get infected, not properly cared for and the base of the ulcer may get adherent to bone. At this stage the ulcer may be indolent, although control of the sepsis combined with local pad and webbing elastic bandage pressure usually heals them. Occasionally they are associated with unsuspected deep venous pathology in the limb as was the case depicted in Figure 281.

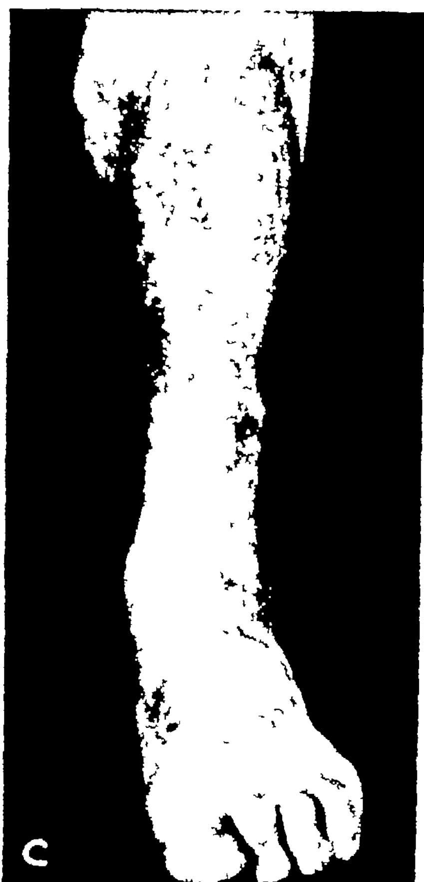


FIG 281

Traumatic Ulcer of the Shin or Footballer's Ulcer

This occurred in a young man of 28 and resisted all attempts at healing for a number of years (including skin grafting) On investigation he was found to have deep vein incompetence Permanent healing has followed an operation in which the ulcer was excised and grafted the veins in its immediate vicinity removed and the deep femoral vein ligated in Hunter's canal After this procedure the pigmentation gradually became less and at the time of writing has almost disappeared A—Before operation B—After operation C—One and a half years after operation

Ulcers due to underlying bone disease.—There are three groups of ulcers which are essentially due to underlying bone disease —

1 THOSE ASSOCIATED WITH OSTEOMYELITIS OF THE TIBIA —These ulcers may present as the typical sinuses from a sequestrum at any time after the original attack of acute osteomyelitis They are relieved by treating the underlying bone disease, that is removing the sequestrum and curetting the sinus if this is necessary



FIG. 282
The ulcer associated with Paget s disease of the tibia.

Another group of ulcers is that which occurs in the papery scar following the old fashioned extensive operations for osteomyelitis of the tibia The thin skin is adherent to bone and continually breaks down even in the absence of any reactivation of the original disease This type of ulcer is extremely difficult to heal permanently but on the other hand it causes the patient little real distress A felt pad cut to cover it, under an ordinary elastic stocking, will support and protect the area It is rarely necessary or desirable to resort to full thickness skin grafting.

Occasionally other ulcers or eczemas about the tibia may be associated with a Brodie s abscess, remaining from the osteomyelitis

2. THOSE ASSOCIATED WITH EXTENSIVE OLD COMPOUND FRACTURES — When there has been an old compound fracture with stripping of the skin over the tibia this skin never quite regains its old vitality as a great deal of its arterial supply may be destroyed. In addition there may be post traumatic and post-thrombotic venous pathology due to the original accident and infection. There may remain a large area of pigmented skin over the front of the tibia which breaks down and ulcerates if it is not carefully protected and supported

3 THOSE ASSOCIATED WITH PAGET S DISEASE —Cases of Paget s disease of the tibia may be complicated by a small ulcer originally traumatic in origin situated over the bowed edge of the bone These ulcers rapidly become adherent to the extremely vascular bone and, contrary to what might be expected are then very resistant to treatment (Fig. 282)

Periostitis and chronic ulcers of the leg.—The bone adjacent to any chronic ulcer of the leg may develop a periosteal reaction In very chronic ulcers of the leg the bones may show considerable periostitis. This must not be confused with other bone diseases, particularly syphilitic periostitis (Fig 283 shows a typical X-ray)

Phleboliths.—Figure 284 shows the X-ray appearances of an old lady with an ulcer of the leg She had numerous phleboliths in the subcutaneous veins—one of which was ulcerating through the skin of the shin and looked exactly like a sequestrum These phleboliths are not uncommon in the aged, and are the same as the phleboliths which are seen so commonly on X-rays of the pelvis



Fig 283
Periostitis of the tibia and fibula under a chronic venous ulcer. The fibula always shows this periostitis reaction first, and it is usually more marked than on the tibia

Pressure sores.—Pressure sores due to badly applied plaster of Paris are occasionally seen, they tend to occur exactly over the prominent bony points, particularly the malleoli In normal limbs they heal slowly but satisfactorily after removal of the plaster, but occasionally (particularly if there has been associated deep vein thrombosis or if there is an associated nerve lesion, or they have become badly infected) they may become very chronic, then they may require excision and full thickness skin grafting, aided perhaps by a search for incompetent perforators or a lumbar sympathectomy

The so-called "arterial ulcer".—This ulcer is undoubtedly a clinical entity although its exact pathology is disputed It occurs in older patients who have arteriosclerosis with and without hypertension It presents usually on the antero-lateral aspect of the lower third of the leg. Some of them start after a specific incident of trauma here, for example a bruise or abrasion These may be explained on the basis of trauma followed by infection in an ischaemic leg Such patients usually have arterial thromboses of one or more of the major arteries of the leg Many such ulcers, however, appear quite

suddenly without any obvious predisposing incident The skin suddenly becomes blue and breaks down Typically these ulcers are very painful in their early stages and the pain has all the characteristics of ischaemic pain (rest pain) Usually the leg shows the other signs of arterial ischaemia (i e



FIG. 284
Phleboliths in the subcutaneous tissues of an elderly woman with varicose veins. The calcification occurs within the lumen of the veins. Occasionally a phlebolith will ulcerate through the skin

coldness, postural colour changes and absence of the dorsalis pedis or posterior tibial pulses or both) *It is probably simply a form of local skin gangrene caused perhaps by sudden occlusion of a branch of the anterior tibial artery*

In this connection Learmonth has drawn attention to the occasional appearance of isolated areas of skin gangrene in the leg in patients who have an aortic thrombosis (either occlusive or non-occlusive) He attributes the

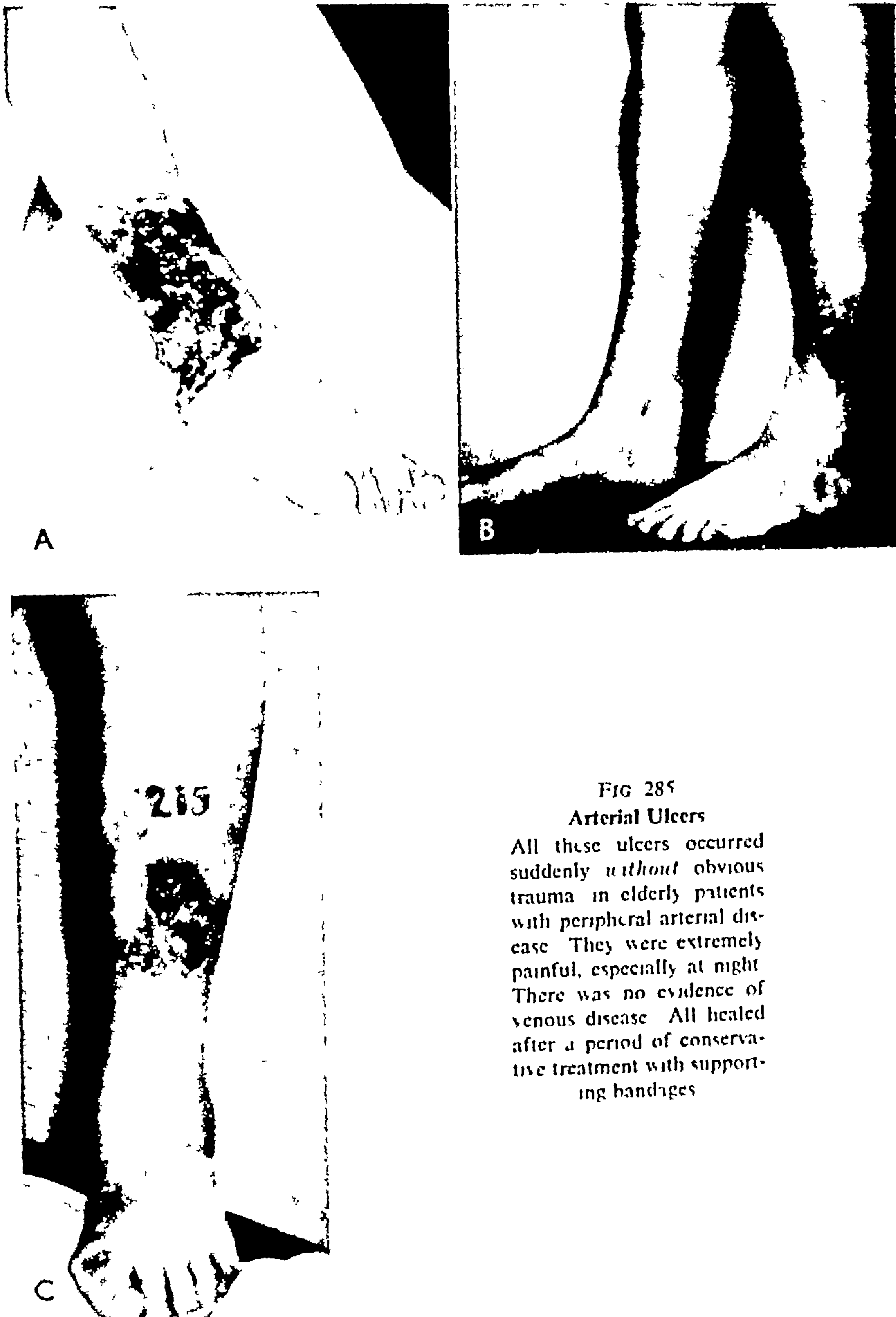


FIG 285
Arterial Ulcers
All these ulcers occurred suddenly *without* obvious trauma in elderly patients with peripheral arterial disease They were extremely painful, especially at night There was no evidence of venous disease All healed after a period of conservative treatment with supporting bandages

phenomenon to showers of small arterial emboli plugging small arterioles in this region, which is anatomically so ill supplied

These ulcers after their initial painful and rather alarming onset, sometimes heal without difficulty on the usual routine dressing and occlusive elastic



FIG. 286
Tertiary Syphilitic Ulcers.
These photographs illustrate all the diagnostic features of these ulcers their multiplicity their punched-out or serpiginous appearance and their occurrence anywhere on the leg (outside the gaiter area)

bandage technique particularly if the skin only is involved However if they are deep and particularly if the tendon sheath or deep fascia becomes exposed skin grafting and lumbar sympathectomy is indicated urgently

Syphilitic ulcers.—Syphilitic ulcers may occur in the secondary or tertiary stages of the disease Secondary specific eruptions may occur anywhere in the legs, consisting of thin easily detached scabs covering small shallow ulcers, which heal rapidly unless they become secondarily infected

In the tertiary stage, gummata may occur anywhere in the leg and may be multiple. These start as dusky red painless nodules which coalesce and break down, forming ulcers which may be circular and clearly punched out, or serpiginous (from the coalescing of a number of single gummatous lesions) The base of these ulcers is formed of yellow necrotic material aptly compared to "washleather." These ulcers heal rapidly with anti-syphilitic treatment giving white firm scars (the so-called tissue paper scars) the skin of which is surprisingly firm and mobile.

The important diagnostic points about syphilitic ulcers are:—

1 They tend to be multiple and painless

2 They typically occur *outside the gaiter area*

3 Their punched out or serpiginous outline and washleather base (when present) are typical.

4. Other signs of specific disease may be present

Tuberculous ulcers.—The term Bazin's disease should be reserved for the rare tuberculide occurring on the calf of the leg This disease, which is very rare in England, must not be confused with the similar lesions of ulcerating pernio occurring in erythrocyanoid legs which are similar and common. The presence of giant cell systems histologically around the areas of fat necrosis in perniosis has in the past led to much confusion between this disease and the true tuberculide This was accentuated by the fact that some of the patients had tubercular lesions elsewhere

Apart from Bazin's disease, primary tubercular ulceration of the skin of the legs with painless enlargement and later caseation of the inguinal lymph glands occurs in children Miller (1953) collected nineteen cases of primary tuberculosis of the skin in children under twelve in which half the lesions occurred in the leg These ulcers occur usually after a local abrasion or scratch and there is often a member of the family, or other contact, with open tuberculosis. Similar primary tuberculous ulcers of the skin are occasionally seen as a terminal phenomenon in children with miliary tuberculosis

A syndrome very similar to the above has recently been described under the name of "cat scratch fever" (Mollaret *et al.*, 1951). In these cases the local lesion is always due to a cat scratch; the regional glands then enlarge and caseate. These lesions pursue a chronic course with eventual healing. There is an eosinophilia and the intradermal test with the specific antigen is positive

Occasionally tuberculous ulcers of the skin of the legs are seen which really arise from deep seated tuberculous lesions of bone, joint or tendon sheath. A chronic ulcer of the skin in a boy of eighteen was found to be due to tuberculous tenosynovitis of the extensor sheath in front of the ankle joint In another boy of fifteen, persistent ulceration occurred in the scar of an incision for old osteomyelitis in the lower part of the tibia X-ray revealed a Brodie's abscess here When this was drained tubercle bacilli were grown

from the pus. Cold abscesses arising from foci in the greater trochanter or more rarely in the pelvis or spine may track down the leg and present as tuberculous ulcers or sinuses on the outer or inner side of the limb

The essential clinical characteristics of a tuberculous ulcer are a ragged, blue, undermined edge, a base of blue, unhealthy looking granulation tissue, and painless enlargement, with perhaps caseation of the regional lymph nodes The ulcers may occur anywhere on the legs and the diagnosis should be made clinically and confirmed by biopsy and the demonstration of tubercle bacilli from the surface of the ulcer or in the regional lymph nodes.

Tuberculous ulcers are rare

Neoplastic ulcers.—Occasionally epitheliomatous change may occur in a chronic ulcer of twenty to twenty-five years duration This malignant transformation, the so-called Marjolin's ulcer is rarely seen now It should however be suspected when an ulcer which has been present for twenty to twenty-five years or so becomes more active and increases in size The edge of such ulcers should always be biopsied. Their malignancy is low The treatment should be in the first place wide block excision with the deep fascia and skin graft. The scar and lymph nodes are then observed every three months We have found that amputation is rarely necessary

Primary epitheliomata of course occur on the leg although rarely compared with other sites Old burn scars, or scars of old osteomyelitis occasionally undergo malignant transformation.

Progressive bacterial synergic gangrene of the skin.—This comparatively rare condition was first described and investigated by Meleney (1949) and the ulcers when they occur on the legs or elsewhere are often known by his name The condition is a rapidly spreading necrosis of the subcutaneous tissues and skin The advancing edge of the lesion is always a centimetre or more in advance of the area of skin necrosis Meleney claims that it is mainly due to the synergic action of a micro aerophilic streptococcus with a haemolytic staphylococcus aureus. These organisms can be obtained from the growing edge of the lesion by special anaerobic culture methods Many other organisms are found as secondary invaders of the gangrenous tissue. It occurs particularly in toxaemic patients whose resistance is low the classical situation is around an empyema drainage sinus or a colostomy

The clinical picture is characteristic. The chief symptom is *severe pain* Within an advancing zone of erythema a raised, tender dusky red area of induration occurs. The skin may become gangrenous in several places over this area and as it melts away it is seen to be extensively undermined.

Prior to 1945 the only effective treatment of this disease was wide diathermy excision of the area followed by treatment with a special zinc peroxide cream (freshly prepared) The area was then skin grafted. Penicillin and the newer antibiotics have improved the outlook considerably and prevent

spread of the lesion , however, not all cases respond to penicillin, streptomycin or aureomycin Chloromycetin and bacitracin may have a more specific effect

These ulcers occasionally occur on the legs, usually in association with some severe general disease or anaemia Sometimes they occur as extensions



FIG 287

Meleney's Ulcers

(A) shows the acute painful looking lesions round the ankle of a woman whose haemoglobin was found to be less than 50 per cent Note the typically undermined edge of the acute lesions
(B) shows a healed case, demonstrating the great area of skin which may be involved in the lesion

or complications of an ordinary venous ulcer In such cases the sudden intense pain, rapid spread and profuse discharge from the lesion is characteristic Whilst the disease is advancing, healing may be occurring from islands of epithelium which have survived the destructive effect of the infection Such a

case is shown in Figure 287 The ulcers which are described as a complication of ulcerative colitis may be of this type

Injection ulcers—When sclerosing solutions such as quinine and urethane and lithium salicylate were in use, the escape of these outside the vein resulted in an area of tissue necrosis, which often ulcerated Such ulcers were typically round and punched out in appearance and took about four to six months to heal These have been much rarer since the introduction of Aethanolamine and the phenol-glycerine solution and also since injection treatment is so much less practised

Ulceration in association with arterio-venous fistulae.—Eczema or ulceration round the ankle may occur in a leg in which there is an arterio-venous fistula either congenital or traumatic.

Congenital arterio-venous fistulae may be either very numerous small and generalised throughout the limb (often in association with cutaneous angiomata) *or* relatively localised in a peripheral part of the limb In this latter type ulceration at the ankle may be the presenting complaint and is directly due to the raised local venous pressure Martorell (1950) states that of nineteen such patients six had ulceration. An unexplained ulcer of the malleolar region in a young adult should raise the suspicion of this condition Examination may then reveal any or all of the following signs —

1 Warm skin over and around the ulcer
2 Excessive pulsation or even a thrill at this point.
3 Pulsating varices
4 A murmur on auscultation
5 Increase in length of the affected leg and foot. This is probably the most important and constant sign Figure 288 shows an ulcer occurring in the leg of a young boy Such ulcers are rarer with traumatic arterial venous fistulae but Martorell describes four such cases

These ulcers heal on the routine compression support with elastic bandages of the local varices. The final cure lies in the eradication of the arterio-venous fistula In traumatic cases this is usually possible in congenital cases it is very difficult and may require several operations and is often manifestly impossible The more localised peripheral variety is more suitable for this type of surgery (Robertson) Amputation was finally resorted to in the case of the boy (Fig. 288) whose leg was ulcerated it was 4½ inches longer than the opposite limb the eczema was intractable, and he bled from punctate spots on it

Ulceration of the leg related to certain general diseases.—Ulceration of the leg has been mentioned as a complication of a large number of diseases in rather a loose manner Certainly in an ulcer clinic it is a noticeable fact that there is a high incidence of other disease such as cardiac failure, arteriosclerosis anaemia and arthritic conditions Now any patient who has a chronic debilitating disease has spent probably a good deal of time either in

hospital or resting Such people are likely to have had calf vein thrombosis at some time or other, and are therefore likely to develop post-thrombotic ulcers Their general debilitating condition further favours the appearance and delays the healing of such ulcers In various blood diseases the haemorrhagic tendency may predispose to the appearance of these lesions Bearing these remarks in mind, it is possible that many of these leg ulcers at present



FIG 288

Congenital Arterio-venous Fistula

Appearance of the limb of a boy of 14 with this condition Note the ulceration, the increase in size and great increase in length of the affected leg

described as specific complications of certain diseases are *in reality* no more than post-thrombotic ulcers, whose appearance and course have been particularly determined by the poor general condition of the patient It is noticeable that patients who are anaemic from any cause have retarded healing of leg ulcers

Ulcerative colitis.—Progressive ulceration of the skin of the legs is described as a complication of ulcerative colitis The lesion is rather similar

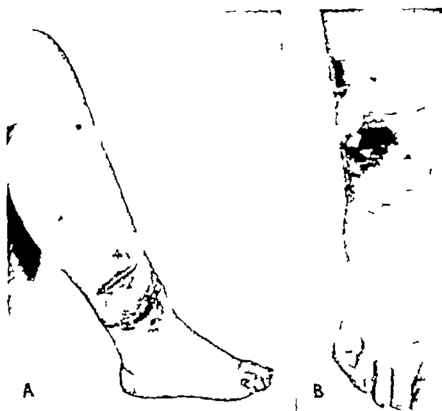




FIG. 289
Ulceration of the legs in a case of ulcerative colitis. Note the absence of haustrations in the left colon, the seat of the colitis. The ulcers healed when the ulcerative colitis was controlled

to the Meleney type of ulcer, and may occur in other parts of the body besides the legs It usually begins and progresses in the active phase of the disease and gets better as the general disease improves or remits Its treatment is (1) general—to control the ulcerative colitis and to correct the anaemic and toxic state of the patient, and (2) local—this is as for Meleney's ulcer

Acholuric jaundice.—Some cases of acholuric jaundice are complicated by an ulcerated ankle In fact the ulcer may be the first symptom which brings the patient to a doctor It is usually a shallow surface ulceration on the inside or outside of the ankle It behaves like a venous ulcer, *i e* it heals on adequate support with elastic bandage or rest in bed

In the same group may be mentioned those ulcers which occasionally complicate the leukaemias

In any condition in which excessive capillary fragility and general debility or anaemia are combined, a particulary severe extravasation of blood is apt to occur in the area of the body where venous pressure is high, *i e* the ankles This condition is seen in old people who show the phenomenon of senile purpura This is usually unassociated with any demonstrable blood disorder or platelet pathology Such people may present with large ecchymosis in the ankle region, quite spontaneously, which occasionally breaks down and ulcerates A poor nutritional state, and particularly a lack of Vitamin C may be a contributory factor in such cases

Gravitational purpura of the legs is not an uncommon phenomenon and occurs in some people for no obvious cause It may occur in the legs of old people on first getting up after prolonged recumbency (*see* Fig 264)

Diabetes.—One of the rarer manifestations of diabetes is the lesion on the leg known as " necrobiosis lipoidica diabeticorum " This is a definite clinical entity It may occur anywhere in the lower leg and ankle region Pathologically it is an area of fat necrosis, as indicated by its name, over which the skin ulcerates It usually heals on routine pressure bandaging and treatment of the glycosuria

Chronic diseases of the aged. The senile ulcer.—Finally we come to an ill-defined group of patients of advanced age, usually over seventy, who have pigmentation with or without ulceration round the ankles Many have numerous associated complaints—rheumatoid arthritis, osteo-arthritis and arterio-sclerosis being very common, and nearly all are in poor nutritional state Many of the above factors go to the production of such ulcers, but they may be summed up in one word—senility

Ulcers due to self-inflicted injuries (artefact or auto-mutilation).—Every year, in the average hospital ulcer clinic, a patient attends (usually an adolescent female, although it does occur in older women and men) who has an ulcer on the leg or foot for which no cause is discernible, this lesion may be due to self-mutilation, *i e* it is an " artefact " ulcer These sores appear

suddenly or at irregular intervals. They are usually situated on the front and outer surface of the leg *i e* a normally non-ulcerated area at a point convenient for the patient s particular form of self-abuse. The surroundings are healthy and the ulcerated surface looks pink and clean but it does not heal. One s attention is ultimately drawn to an oddness of the patient s personality or behaviour which arouses the suspicion that the sore could be self inflicted and regularly retraumatised so explaining its failure to clear up The stigmata of hysteria may be present, such as anaesthetic palate, pharynx and cornea, glove and stocking anaesthesia etc When the limb is dressed in the ordinary way *i.e* frequently changed dressings held by a bandage the ulcer continues because the patient has access to the wound and can continually apply irritants. If the possibility of the patient interfering with it is considered, and an occlusive casing such as a plaster of Paris bandage is applied over a suitable dressing, thus preventing interference healing follows progressively Recurrence may occur after the dressing is removed, and the procedure has to be repeated An X ray may show foreign bodies inserted deeply into the wound in one such patient numerous gramophone needles were so revealed There may be family or economic reasons for the maintenance of the ulcer This is fortunately not so common now as formerly when the possession of a large unhealed ulcer of the leg was part of the stock in trade of many beggars

Tropical ulcers.—A detailed consideration of tropical ulcers is excluded from this book as they are not seen in temperate zones But in any case of unusual ulcer of the leg with a history of recent sojourn in tropical countries leishmaniasis, moniliasis and other rare fungus diseases should be considered Pellagra used to be a common cause of swelling and ulceration of the legs and was so again in the Japanese prisoner of war camps of the 1939 45 war but in normal peace time conditions it is very rare.

CONCLUSION

From what has been said in this chapter it is apparent that when a patient presents with an ulcer of the leg the differential diagnosis may require considerable clinical acumen A detailed history and an examination of the patient as a whole are essential for their diagnosis and treatment.

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CHAPTER XVI

THE CONSERVATIVE TREATMENT OF VENOUS ULCERS, ECZEMA, AND THE POST-THROMBOTIC SYNDROME

SINCE the essential basic lesion of venous ulcers and eczema is a persistent ambulatory venous hypertension in the subcutaneous veins and venules, conservative treatment for healing these lesions is aimed simply at reducing this high venous pressure This can be achieved in two ways —

1 By placing the patient flat in bed with the feet raised until they are a little above the level of the heart This effectively relieves all venous hypertension in the lower limb, and it has long been known that venous ulcers, even extensive ones, will heal progressively when this is done When the patient starts walking again the ulcers re-appear, unless some further measures are instituted

2 By surrounding the foot and ankle with a firm elastic compressing bandage Such a bandage exerts continuous elastic pressure on the subcutaneous venules Moreover, every time the calf muscles are exercised, as in walking, the subcutaneous tissues are squeezed and massaged between the external compression and the muscle, and the venous blood is driven out Thus these bandages, if firm enough and well applied, to some extent restore the efficiency of the calf pump This method of treating ulcers and venous lesions of the lower limb has much more to recommend it, as the patient is fully active throughout the treatment

The application of these bandages so that they maintain continuous firm elastic compression round the ankle and lower leg is a great art In fact the success of this method varies directly with the amount of trouble and attention to detail which is expended on applying, or teaching the patient to apply, these various forms of elastic compression

Before describing in detail the various methods, it must be emphasised once more that *it is not the particular ointment or lotion which heals an ulcer it is the elastic compression* Within reason, it does not matter what is applied to the ulcer The only important thing about the local application is that it must do no harm ! The skin round most ulcers is extremely sensitive to any but the blandest form of application Tulle gras, zinc oxide in castor oil, or plain olive oil are safe But we should like to issue a specific warning against penicillin cream, sulphonamide creams, or any ointment containing flavine All these applications may produce violent sensitivity reactions and a fierce eczema round the ulcer which takes months to subside

Before passing on to describe in detail the two principal types of pressure bandaging technique which may be used, it is interesting to recall that it was

Richard Wiseman, the Royalist surgeon who first applied the principle with his laced stocking. But the first practical description of the technique we owe to Dr Thomas Baynton of Bristol (1797) His remarks show that the problem has altered little in the intervening hundred and fifty years. The following are extracts from his monograph entitled "Descriptive Account of a New Method of Treating Old Ulcers of the Leg."

"The common methods of curing old ulcers are so tedious, troublesome and uncertain, and they so often become dangerous in their consequence, that I think it will be admitted that any attempts calculated to lessen the sufferings of the patient, and the trouble of the surgeon will be entitled to attention as it is known by all practitioners of experience, that very few of those maladies which compose the catalogue of human misery occasion in many instances more perplexity to the one or distress to the other than this disease.

About the commencement of the year 1792, after having experienced repeated disappointments in my endeavours to obtain permanent cures for some patients with whom I had taken more than common pains and for whom I have tried rest in a horizontal posture exercise, precipitate, bandages and every other remedy I was acquainted with that authors had recommended both alone, and conjoined with the most approved internal medicines I determined on endeavouring to bring the edges of those ulcers, that might be placed under my care, nearer together by means of slips of adhesive plaster having frequently had occasion to observe that the probability of an ulcer continuing I found, depending much on the size of the cicatrix that remained after the cure appeared to be accomplished and well knowing that *the natural shield of the part the true skin was a much more substantial support and defence as well as a better covering than that frail one that is obtained by the assistance of art in the common methods of cure*

At this time I had in view to lessen the probability of those ulcers breaking out again that might be healed by the means I proposed to make trial of as well as an expectation of being able, if the application could be borne by my patients, to gain some time in the cure.

Little did I think that a method so simple as the mere application of a slip of adhesive plaster in a particular way would prove the easiest, most efficacious, and most agreeable of all applications, of a wound so proverbially irritable as an ulcer much less could I expect that it would lead me to the discovery of curing with ease, those diseases that had so long exercised my patients, and defied my industry

Opportunities to try it were not long wanting. All patients were at first enjoined to keep the affected part as much at rest as possible, but as it happened that many of them were from the nature of their occupations, obliged to work, and stand a considerable part of the day I soon discovered that their recovery kept equal pace with those who confined themselves to their beds this circumstance, so contradictory to my own and the almost universal experience of surgeons at first excited a considerable degree of surprise I think it will appear probable that the means, *i.e* the bandage proposed may produce their good effects by preventing the distension of the vessels, and in that way obstructing the supply of fluids that they had been accustomed to receive and pour out, which it will be recollected were generally increased and vitiated in proportion to the exercise of the part, and

will now be found to be in an equal or greater degree diminished and improved by the plan that it recommended

In many of those neglected ulcers that I have met with among the poor the discharges have in two or three days been reduced to the quantity that is usually afforded by the healthiest sores Those ulcers which before the application of these means were so offensive as to leave an intolerable foetor when they were dressed, have in the same space of time, or nearly as soon, become perfectly sweet and inoffensive

Materials.—Common plaster or diachylon is spread thinly upon slips of *porous* calico of a convenient length The pieces of bandage so prepared are cut into slips of from two to three inches in breadth, of a length that will after being passed round the limb, leave an end of about four inches

Calico is more pervious and appears to possess more of the accommodation properties of true skin It is elastic, soft and accommodative and a much better conductor of that morbid heat which so constantly affects inflamed parts, which it is essential to remove "

Baynton's instructions may be summarised as follows :—

1 Clean off hair for easy removal of dressing and prevention of matting with discharge

2 Bandage early in the morning before the swelling has appeared

3 Bandage strips, width two to three inches, long enough to overlap the circumference of the limb by four inches

4 Apply the centre of the strips to the limb diametrically opposite to the ulcer, bringing the two ends round so that they overlap on either side of the ulcer

5 Begin the encircling bands one inch above the ulcer and finish one inch below it, overlapping previous turns by half to two-thirds of their width

6 Bandage the leg with several layers of soft calico evenly from the foot to the knee as *tight* as the patient can bear

7 *After-care* Moisten the bandage with lavender water to make the limb more comfortable and to facilitate its removal

8 *Exercise* Patients should do so daily.

9 *Change bandage* Dressings must at first be renewed twice daily.

10 *Subsequent care* Support the limb for several months with a bandage

11 " Pursue plan with steadiness, attention and requisite care "

Result: " Discharge, removal of offensive smell, abatement of pain and fungus growth prevented "

12 *Conditions not healed* Diseased bones, syphilis, caries, scrofula were not healed

The only unsuccessful case was an ulcer 1 x ½ inch beneath the outer ankle parallel to outer border of foot

These excellent instructions were to a large extent lost and forgotten It was not until 1930 that Arthur Dickson Wright, of London once again re-taught the value of elastic compression

MODERN TECHNIQUES

In general there are two main ways of applying the principles of pressure bandaging to a leg. These are —

1 The application of some form of medicated bandage (diachylon Unnas paste etc) which is *left on* untouched for a period varying from a week to a month or more

2. The application of a dry elastic webbing bandage from toes to knee over a dressing and pressure pad over the ulcer This involves the intelligent co-operation of the patient as he has to learn to apply the bandage correctly himself every morning.

These two methods are complementary and some patients may prefer or do better on one than another In refractory or careless patients, or patients of low intelligence method (1) is probably better In patients who co-operate well method (2) will be found to work very well

The detailed application of these two methods will now be described

THE OCCLUSIVE PRESSURE BANDAGE METHOD

The benefits of a pressure bandage are as follows —

1 **To the leg.**—By its elastic pressure the swelling of the limb due to oedema incompetent veins (deep or superficial) inflammatory reaction and lymphatic disturbance is reduced The sustained support prevents it from re-forming By compressing the varicose veins a normal venous circulation, mainly by the deep veins is facilitated The pressure bandage reinforces the calf muscle pump return of deep venous blood from the leg.

2. **The infection and discharge**.—Continuous protection of the legs by two or three thicknesses of bandage cushions the defective skin from repeated moment to moment trauma and excludes a continuous re-infection No steps are taken to control the bacteria of the ulcer Experience shows that this is unnecessary and only ordinary cleanliness is observed The discharge as it soaks through the bandage is wiped off with a soapy cloth or a pad of wool and an absorbent dressing is put over the moist area of the bandage and changed when the discharge is excessive Small holes may be cut in the bandage to facilitate its escape The discharge and smell cease after a time No matter how foul and infected the ulcer no antiseptics or antibiotics are used to overcome the sepsis Pain gradually subsides and a clean granulating ulcer and healthy skin emerge on removing the bandage and wiping away the accumulated pus The application of gentian violet 1 per cent in 70 per cent.

spirit to the ulcer surroundings is well tolerated, and assists in overcoming a fungoid infection It tends to dry a skin which is often catarrhal and pustular about the ulcer

3 **The ulcer.**—The reduction of swelling of the limb automatically *lessens the size of the ulcer* The tension of the bandage brings its edges

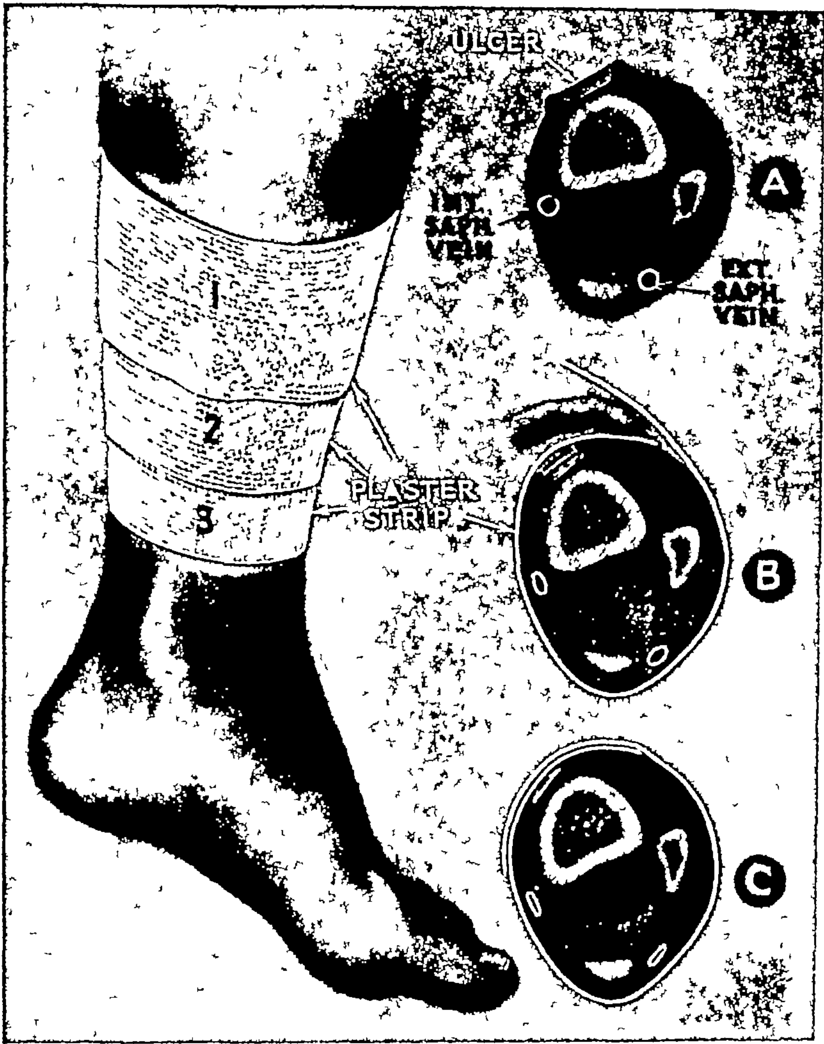


FIG 290
Baynton's strips which approximate (B) and flatten (C) the edges of an ulcer

together The pressure on it flattens the raised edges and granulations fill up the cavity to the level of the skin, thereby making the edges and base smooth This facilitates epithelialisation which follows progressively One patient with an ulcer due to incompetent ankle communicating veins for two years, had dressed it three times a day during this time (over 2,000 dressings) taking a codeine tablet before each change It was healed by one occlusive

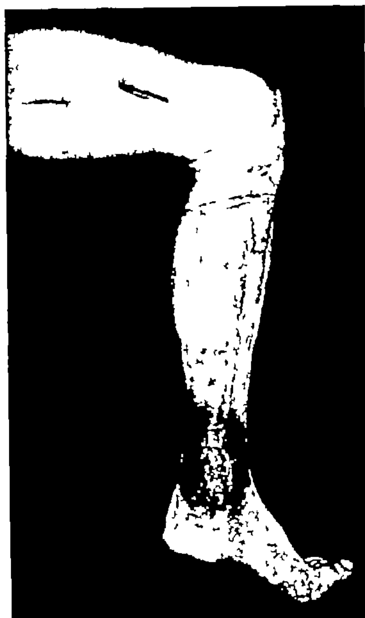


FIG. 291

An ulcer (1955) due to incompetent ankle communicating veins following deep thrombophlebitis, which complicated a compound fractured femur (note scars) in 1941 The ulcer has been present for seven years. The circle shows its size when a pressure diachylon bandage was first applied. The dark spot in the upper and posterior quadrant of the circle is the ulcer after two weeks of the bandage. Note the considerably pigmented area and the tendency to an equinus and pes cavus position.

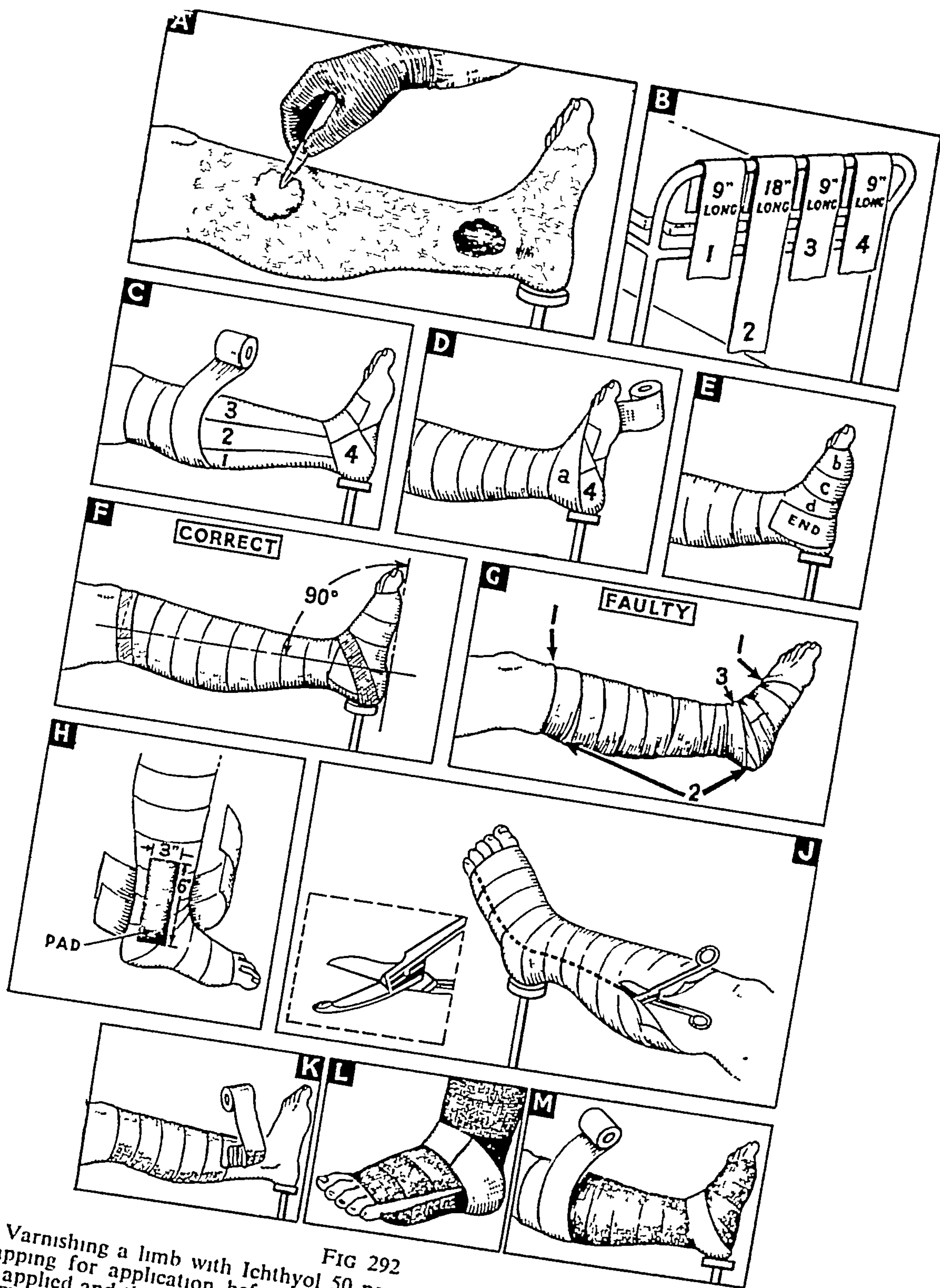


Fig 292

A Varnishing a limb with Ichthyol 50 per cent B The preliminary strips of strapping for application before bandaging a leg C The preliminary strips are applied and the bandaging is begun D The method of turning at the heel E The foot bandaged F The leg, pressure bandaged, and secured at the heel and knee G A faulty bandage, with too little skin coverage (1) gaps (2), unequal overlap and creases (3) H A pad for additional pressure being applied over a compression bandage J Removing an adhesive bandage Note the powerful scissors with a beak K Application of a medicated bandage Note the method of forming a pressure pad over an ulcer L A detensing cut to avoid pain from the bandage during walking A strip of strapping is applied round the heel M Applying the pressure bandage over a medicated bandage It may be put on from above downwards or from below upwards

pressure bandage over Baynton s strips in three weeks Figure 291 illustrates another promising result.

Criteria of a good occlusive pressure bandage.

1 It must be comfortable and secure *i e* it must not cause irritation pain or sensitivity reactions

2. It must be compact and allow outdoor footwear to be worn a slipper is undesirable

3 It must maintain its compression of the leg (*i e* not only the ulcer)

In applying these dressings the following conditions are observed (Fig. 292) —

1 The bandage begins immediately below the knee and finishes at the root of the toes (Fig. 292*f*) or vice versa

2 *Its tension* is considerable and is sustained evenly from the start to the finish being estimated individually for each leg.

3 *Skin coverage* All of the skin between the knee and the toes is covered at least twice possibly thrice if the oedema is marked this ensures even pressure throughout There are no gaps between its turns or the cuticle bulges through especially at the heel where it becomes oedematous blistered chafed, eczematous and painful (Fig 292*g*)

Application.—The application of the bandage is considered under the following headings —

1 The operator *i e* the surgeon or trained assistant

2. The bandages

3 The patient s limb

The operator—For consistent success, the bandages are put on by the surgeon or a trained assistant The ulcerated leg merits and requires the surgeon s attention resourcefulness and skill The delegation of the bandaging to assistants or to senior nursing staff is done only when they are trained trustworthy and interested There is no more rewarding treatment than the progressive healing of ulceration and eczema of years standing and this is the essential precursor of a successful operation Bandaging requires time One patient s friend observing the process, remarked You are tailoring that bandage on." This captures the spirit of the care needed. With the relief of pain and healing enthusiasm grows. For the ischaemic or senile limb where there is the danger of skin necrosis the surgeon should undertake the first few bandages.

The bandages.—A bandage suitable for each leg is selected as the limbs of the same patient may need a different sort. There are three types available all are 3 inches to 3½ inches wide and about 4 to 6 yards long when extended

1 The extensible adhesive bandage.

2 The medicated bandage (non-extensible)

3 The plain extensible bandage





FIG 293
Ulceration of the legs (February 1955) Haemoglobin = 58 per cent



A



B

Fig. 294
The same legs as Figure 293 May 1955 Treated by ambulation and Diachylon pressure bandages



A



B

FIG 295

A and B 'Elastoplast' dermatitis

The extensible adhesive bandage.—There are two forms of extensible adhesive bandage (or strapping) those which owe their stickiness to being spread with a resin-lead oleate mixture (diachylon) and those spread with a rubber zinc mass. The latter are *not* recommended as they cause severe skin sensitivity reactions in about a quarter of the patients (Fig. 295A and B) There are numerous proprietary forms *e g* Dalzoflex, Elastoplast, Flexoplast etc

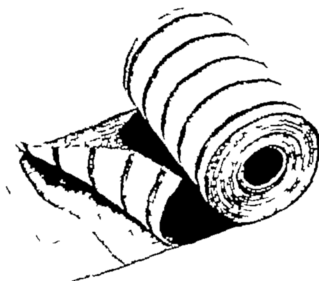


FIG. 296
A roll of ventilated diachylon strapping.

1 **The soap-lead-resin (diachylon) plaster** —This is the adhesive bandage of our choice (Fig 296) and is used because nearly all patients skins will tolerate it, including many with eczema It has an emollient action on ulceration and it seldom causes sensitivity or irritation A few persons cannot stand it, for there are some who are unable to bear any adhesive on their skin

Diachylon is not so sticky as that spread with the rubber zinc preparation It is adhesive at body temperature, but in cold weather unless kept in a warm place the adhesive tends to become brittle and dry until it has been warmed by the skin Ordinarily it will be effective on a limb for a month or occasionally six weeks It tends to become loose at the ankle where there is considerable movement, but patients vary in the care they can take of their bandage Some older persons whose limb or limbs need continued protection have no difficulty in wearing one unchanged up to a year but those working will soil and loosen their bandage to uselessness in three to five weeks.

Technique of applying pressure bandage.—The method to be described has been proved by long use and the results are gratifying Modifications should be made only after a careful trial An ulcerated leg would never come to the surgeon if it would heal with ordinary bandaging skill and discipline

are needed and the technique outlined here is one proved example of it (Fig 292)

General plan and caution.—The bandages are supplied with sustained even tension, with equal overlap, without fold, crease or twist from the knee to the toes; this ensures comfort If a bandage is applied too tightly and is patiently borne, the skin over the dorsum of the foot, malleoli or tendo-Achillis may slough, worsening the patient's plight. The patient with a painful bandage is warned to report immediately or to cut it over the painful areas but not to remove it

The ulcerated leg without varicose veins.—The ulcerated leg without varicose veins still requires the adhesive pressure bandage, because the deep veins and ankle communicating are often inefficient and there is usually considerable oedema of the limb, needing pressure to express it The firm bandage limits the regurgitation of blood through inefficient perforating veins into the superficial tissues

Preliminary skin treatment. Shaving.—Hair is usually absent from an ulcerated leg It returns to some extent when the ulcer is healed and the defective veins are tied (When considerable hair is present, it is shaved)

Skin varnishing.—Some legs itch under an adhesive bandage, whilst the skin around an ulcer may become eczematous or pustular beneath it Both reactions suggest that the adhesive pressure bandaging be abandoned, but these complications can often be prevented by painting the limb with a varnish consisting of equal parts of icthyol and water, which is non-irritating and soothing, even in acute eczema (Fig 292A) The varnishing begins on the healthy part and ends at the ulcer or eczema, painting the ulcer first will distribute the organisms to normal skin afterwards When the varnish is dry the bandage is put on, the resulting tackiness assists its adhesion Gentian violet 1 per cent solution in 70 per cent spirit or Tinc Benzoin Co. are alternative applications The former stains the clothing; the latter causes smarting or eczematous or inflamed skins, but is satisfactory for a dry surface with a healing ulcer

Baynton's (encircling) strips.—The technique described by Baynton of approximating the skin edges of an ulcer by encircling strips of diachylon plaster overlapping on either side of the ulcer by two inches is excellent and is used for ulcers larger than 1 5 centimetres in diameter, especially for those that are deep or intransigent to heal The strips of one-inch ventilated diachylon plaster begin two to four centimetres above the ulcer and continue the same distance below it They overlap each other by fifty per cent of their width (Fig 297) The tension is moderate and is judged for each patient according to the amount of oedema and fat present

The longitudinal strips.—The application of three longitudinal strips of bandage about the ankle is vital for the comfort and success of the compres-

sion bandage. They protect the tendo-Achillis, malleoli and sharp edge of the tibia from the encircling pressure prevent excoriation and possibly laceration of the skin about the ankle by creases in the bandage. The pain and apparent intolerance of some patients to the compression adhesive is frequently explained by the omission of these ensheathing pieces In cold weather the

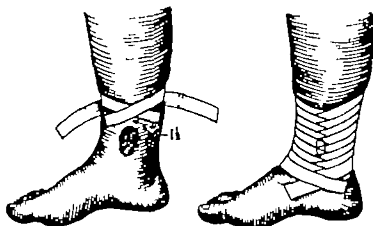


Fig. 297
The application of Baynton's strips of 1 inch diachylon strapping.

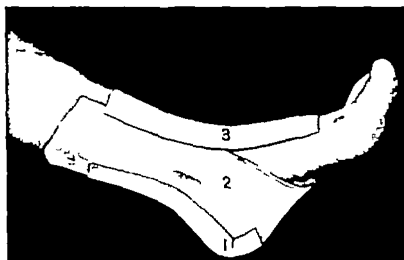


Fig. 298
The application of the three longitudinal strips.

diachylon strips are warmed (*e g* before a fire on the hot lid of the steriliser or on a hot plate) to improve their tackiness and to facilitate application.

Four pieces of bandage are cut, three 9 inches (22½ cm) and one 18 inches (45 cm) long, the aim being to encase the ankle joint and cover any ulcer or eczema present (Fig 292B) The first short length is fitted to the back of the ankle beginning under the heel and passing upwards over the tendo-Achillis (Fig. 298 (1)) The long or saddle strip is placed with its centre below

the heel, over the malleoli and up on to the sides of the leg, it slightly overlaps the edges of the first piece (Fig. 298 (2)). The third strip covers the dorsum of the foot, the flexure of the ankle and front of the leg (Fig. 298 (3)). These pieces are moulded to the limb without fold or crease The fourth strip encircles the heel and front of the ankle, holding the first three in place, and, as will be seen later, avoids a tight turn of bandage here that might limit movement or cause pain (Fig 292c).

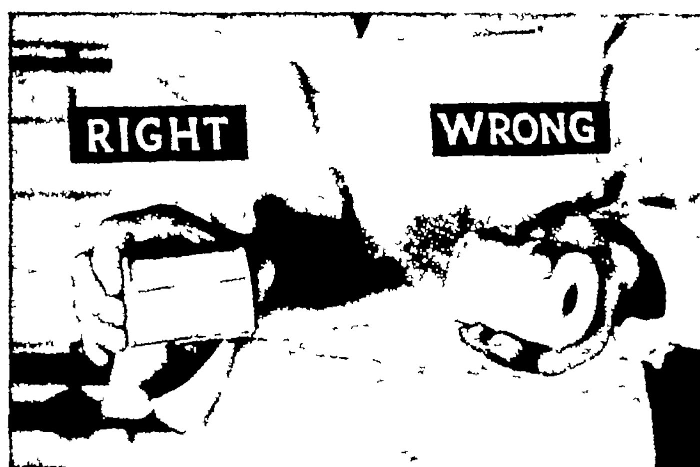


FIG 299
How to hold an adhesive bandage

The position of the foot for the bandage.—The foot is held at right angles to the leg throughout, this avoids transverse creases of the bandage and chafing the back and front of the ankle (Fig 292F). During the bandaging the foot tends to droop and, if uncorrected, would cause this creasing in the flexure of the ankle during walking (Fig 292G).

How to hold the adhesive bandage.—A good method of holding the extensible adhesive bandage is shown in the diagram (Fig 299) This grip prevents the fingers compressing the tacky bandage surfaces together so making it difficult to unrol which would require considerable effort and cause it to be put on w ... s excessive tension, leading to pain

The degree of t ... n varies with the affected limb Some legs with ... atous, some have much subcutaneous fat, othe ... poor blood sup ... arterioscle ... be swollen b ... cted ulcer ... lthough ... applied ... vidual ... oedemate ... as ... layer ov ... d ... erted A

to four thicknesses of bandage may overlap the joint If thoughtlessly applied excessive tension will occur here and cause difficulty in walking pain cyanosis, swollen toes and sleeplessness

For the average limb the bandage is put on with a fifty per cent overlap throughout, with moderate tension On the thin, poorly nourished limb it fits snugly but is not tight The eczematous limb or one which is healed needs a lighter bandage, overlapping by one-third is adequate.

Pressure bandaging—When the longitudinal strips are applied the strapping is put on It may be started at the knee or the toes It is traditional to teach that a limb should be bandaged from below upwards (Fig. 300) but there are advantages in doing it from above downwards An adhesive bandage stays on for several weeks and when it is put on from the foot upwards its edges are prone to curl when putting on a stocking and when moving in bed Another factor in pressure bandaging a swollen leg from the toes is that this expresses the oedema upwards which is desirable

Applying a bandage from above downwards is apparently irrational for it seemingly presses fluid into the foot and toes but it then passes deeply into the deep veins and lymphatics and is carried upwards The tight bandage to the toes prevents it re forming Since 1945 one of us has practised and taught bandaging from the knee to the foot no ill-effects have been seen and satisfactory results have been achieved

The patient s foot is held dorsiflexed and steady by pressing it against the operator s thigh, so that the same tension is exercised throughout Alter natively the heel may be supported on a foot-rest or held by an assistant.

The bandage begins at the tubercle of the tibia round the smallest part of the calf below the knee If it is started lower after a week or two it may slide down the leg like a stocking and crease uncomfortably about the ankle (Fig. 292G) The turns pass from within outwards overlapping each other by half to two-thirds of the width of the bandage according to the amount of swelling. The bandage is taken round the leg regularly almost to the point of the heel thus covering part of the heel band (Fig 292D) It is then taken across the foot to the root of the toes, avoiding undue tension creases or twists. The turns pass back round the foot to the point of the heel, so covering the lower edge of the encircling heel band the fifty per cent. overlap being continued (Fig. 292E) The bandage finishes over the internal or external malleolus The ankle is now fully enclosed for the heel is already covered by the preliminary strips. (Its effectiveness is illustrated by Figs 293 and 294)

The upper edge of the bandage below the knee and at its end above the malleoli are secured by encircling zinc oxide strips one inch wide (Fig 292F)

Emphasis has been laid on the danger of painful pressure on bony points like the malleoli the base of the fifth metatarsal the dorsum of the scaphoid and the sharp edge of the tibia in practice it is rare

The complete enclosure of the leg presents no difficulty except in those patients with bulging calf muscles and slim ankles, and especially those with the inverted champagne or beer bottle legs Occasionally the ulcer is just below this muscular protuberance, which is made worse by the contraction of the scarred skin and fat at the lower third of the leg It may be difficult to obtain even pressure here without the bandage creasing and cutting in below the muscles It is overcome by a layer of thick gauze, wool or cellulose foam, which makes the contour gradual and fusiform



FIG 300
Bandaging from below upwards

Pressure pads.—Additional pressure to an oedematous ulcerated area is sometimes necessary, especially above, behind and below the malleoli Local direct pressure by the bandage on the hollows behind the ankle is not possible because of the prominence of the malleoli which cause the bandage merely to bridge the skin between it and the heel Again, a deep ulcer with raised, hard edges and indurated depressed base must be flattened to disperse the oedema and congestion and to make a level surface for the epithelium to cover. If the base of an ulcer and the area above it are palpated with the gloved finger, fluctuant veins can often be discerned and for healing these must be kept collapsed, the pressure pad achieves this

The pressure is obtained by pieces of felt or cellular foam (Fig 301) These are comfortable and they allow the passage of perspiration and discharge We do not use sponge rubber as it tends to make the skin hot and moist, which is favourable for fungoid growth and pustular eruptions A piece *6 inches by 3 inches (15 cm by 7 cm) is a convenient size, and it extends upwards from the tip of the malleoli, being designed to press on the communicating veins above the ankle as well as the ulcer* It is placed over or under

the longitudinal strip and held by the bandage It may be put on the outside of the bandage and secured by separate turns of strapping (Fig. 292H)

When extra pressure seems necessary we prefer to apply the pad on the outside of the bandage above over and below the ulcer Thus continuous pressure is obtained and if the tissues cannot withstand it the patient can remove the external pad but retain the occlusive bandage.



FIG 301
Cellulose foam.

Easing a painful bandage.—A simple method of easing the pain caused by a tight bandage is to incise it for one inch over the painful place with scissors or sharp pen-knife The bandage gapes elliptically and the opening is patched with a piece of sticking plaster to prevent the skin bulging through and becoming chafed (Fig. 302)

Removal of an adhesive pressure bandage—When removing an adhesive bandage with the scissors painful scoring of the skin beneath may occur It is avoided by using a powerful pair of scissors with a beak in front of the cutting blade The difficulty is mainly at the ankle where there are several thicknesses of bandage (Fig. 292J) The strapping is cut on the side opposite to the ulcer from the knee to the ankle behind the malleolus and from the toes along the border of the foot. The diachylon plaster peels off easily with little pain There are two ways of detaching it—the quick and the slow From personal experience the former is preferable An assistant holds the leg whilst the top of the cut bandage is gripped firmly with both hands and in one quick sweeping movement it is peeled off The removal in a single stroke is the secret of its painlessness The alternative favoured by nervous people is that of unwinding or detaching the strapping helped by dabbing with methylated ether or a proprietary preparation called Zolf

Cleaning the ulcer—Considerable odorous discharge may have collected about an ulcer underneath a bandage. When it is wiped away with cetavlon

1 in 100, or roccal, 1 in 1,000, a smooth healthy granulating lesion is revealed Sometimes the adjacent skin is macerated and pustular, but painting the area with equal parts of ichthyol and water or gentian violet, 1 per cent in 70 per cent spirit, and changing the bandage more often will give relief The pressure dressing should not be discontinued for this reason

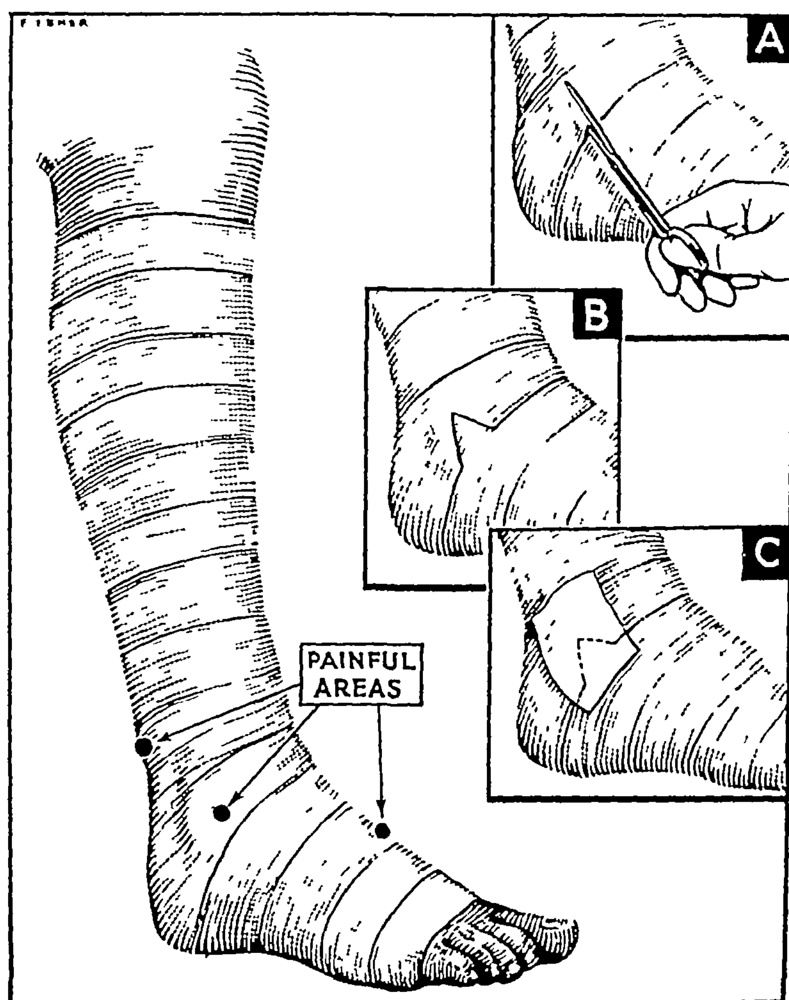


FIG 302
Easing a painful compression bandage

When to change the bandage.—The pressure adherent bandage is changed for pain, smell, discharge and wear

1 *For pain*—The bandage that is persistently painful for twenty-four hours should be changed, it may be too tight and ischaemia with necrosis of the skin is the danger It may have been incorrectly applied, with resulting creases scoring the skin in front or behind the ankle, at the outer border of the foot (pressure on the fifth metatarsal) and at the upper calf (being too high behind the knee) Patients vary in their toleration of discomfort and tension but a properly applied bandage is comfortable, giving a sense of well-

being and support to the leg. The elimination of pain is an essential of the ambulatory treatment of ulcer The technique is practised until this requirement is satisfied for every limb and person.

2. *For smell or for copious discharge*.—Discharge is wiped off the bandage as required and its formation usually subsides in a few days A ventilated bandage assists the escape of exudate When the odour is offensive the dressing should be renewed early

3 *For ineffectiveness*.—The bandage may have become loose and is therefore ineffective. It may have slipped down the leg, especially when it has not been started round the narrow part of the upper calf

4 *For wear and dirt*.—Bandages wear out and become dirty This varies according to the patient s work and care some dressings are soiled in a week, and others are clean after six weeks. Wearing a stocking over the bandage by day and night is a useful protection

Medicated bandages.—The skin of some legs is sensitive or eczematous and will not tolerate the adhesive bandage in direct contact with it. A bland or emollient application is needed. This can be supplied as a bandage impregnated with such a substance.

There are numerous medicated bandages consisting of inextensible thin cotton fabric saturated with variations of Unna s paste They may be home made or many proprietary brands ready to use are available

Unna's paste.—The composition of Unna s paste is approximately zinc oxide 1 gelatine 2, glycerin 3 water 4 parts. It is well tolerated by most skins and it rarely irritates Ulcers and eczema heal beneath it. Such dressings can be worn unchanged for weeks Dalzoband and Viscopaste are examples of proprietary Unna s paste dressings

Other medicated bandages contain in addition to the zinc paste ichthyol coal tar urethane or calamine in 1 3 per cent. strengths

An Unna's paste bandage.—A home-made Unna s paste bandage consists of several thicknesses of gauze or of extensible cotton crêpe impregnated with the paste It must not be bulky or the patient will be unable to put on outdoor shoes

A sterile Unna s paste dressing is made as follows Four yards of 3½-inch cotton stockinet, crêpe bandage or several thicknesses of gauze roll are loosely rolled and sterilised As the Unna s paste is boiling the autoclaved rolls are dropped into it When they are saturated they are lifted on to a sterile dish until they are cool enough to handle

Unna's paste and ichthammol 1 3 per cent.—A bandage containing these substances is invaluable when acute, painful or weeping eczema is present. It is soothing, does not become hard on drying and so chafe the

skin The proprietary bandages Ichthopaste and Dalzoband No 3 contain these agents and are suitable

Unna's paste and coal-tar 1 - 3 per cent.—For the dry chronic, coarse, scaly eczema, this preparation frequently stimulates normal keratinisation of the skin A coal-tar bandage should not be used on ordinary skin, a catarrhal or moist eczematous surface, for it may cause pain and an acute exudative dermatitis

Unna's paste, urethane 2 per cent. and calamine 5·75 per cent.—This is an invaluable dressing for the elderly, infirm or bedridden patient whose leg has a moist eczema with encrustations and inert ulceration, where the arterial supply of the limb is poor and years of such trouble have converted much of the skin and subcutaneous tissue about the ankle into scar tissue This bandage can be worn for weeks unchanged An alternative is —

Linimentum calaminae.—This consists of calamine ½ - 1 oz , wool fat 43¾ m , oleaic acid 24 m , arachis oil 5 oz , solution of calcium hydroxide to 10 oz A bandage impregnated with it is valuable for the senile leg The oil content prevents painful adhesion and drying of the dressing

Strength of agents.—It is wise to begin with 2 per cent of ichthammol, coal-tar, calamine and to work up to 3 per cent The simple Unna's paste is the least irritant and will suit the inflamed leg best, especially in the cold weather, when a chilblain effect may be superimposed

Bandaging an eczematous leg.—For a leg with eczema to be comfortable, free from itching and to heal it is essential for it to be cool A thick dressing retains heat and discharge and where the latter is, fungi flourish A thin porous dressing which allows ventilation is needed

Thus, adhesive plaster, either of zinc and rubber or diachylon, is unsuitable for the treatment of acute eczema because it prevents evaporation, tends to be hot, and causes maceration, pustules and itching

The application of a medicated bandage (Fig 292K, L, M) —The leg is supported at the heel The limb is cleaned of scales and discharge with cetavlon ½ - 1 per cent (aqueous solution) and dried It may be advisable to paint the skin with ichthammol 50 per cent (aqueous) or gentian violet The Unna's paste or other medicated bandage begins at the tubercle of the tibia and is wound snugly towards the ankle, each layer covering the preceding one by a half to two-thirds without tension The heel is covered entirely The dressing stops at the root of the toes Over the ulcer several layers are superimposed in order to make a pressure cushion (*see* Fig 292K).

As these bandages are of thin cotton fabric, if wound tightly they are prone to cut into the skin about the ankle and outer border of the foot A " detensing " cut is made along the outer border of the foot to the ankle to avoid chafing (Fig 292L)

The pressure bandage.—A medicated bandage gives no support and the compression is supplied either by a bandage of stockinette crêpe or elastic webbing three inches wide It is put on tightly (Fig 292M) When there is no moist eczema and the leg is merely intolerant of direct strapping and especially if there are varicose veins and oedema the medicated bandage is covered by a ventilated diachylon bandage which will last for four to six weeks.

Medicated bandages as a rule are changed more frequently than an adhesive bandage. When the discharge is copious it is taken up by wool pads applied to the outside and changed daily the bandage being undisturbed for from one to seven days A non-adhesive pressure bandage usually slackens in a fortnight The compression must be sustained until healing is complete

Patients with venous disorders of the lower limb and who are constitutionally inclined to skin eruptions will develop eczema of the leg and elsewhere too Some by frequently dressing their legs carry the infection to their face, neck, upper limbs and trunk. As a rule, as the legs improve these lesions subside A medicated bandage can be applied beneficially to the upper limbs trunk or neck. The exclusion of wear and tear by secure light dressings is effective treatment for any infected or eczematous skins

THE ELASTIC (OR BISGAARD) BANDAGING TECHNIQUE

Plain, *i.e* non-medicated and non-adhesive bandages are used in the second type of bandaging technique They must be robust, and possess some extensibility the latter may be supplied by their rubber thread content, *i e* elastic bandages, or alternatively by their peculiar weave

Elastic bandages.—Some elastic bandages will stretch longitudinally *i.e* one-way stretch, and others both longitudinally and transversely *i.e* two-way stretch

Various types of elastic bandages are available but the common webbed crêpe surface is better as it does not slip like those with a smooth surface

Such bandages are useful to obtain healing and then to support and protect a healed leg for three to six months until the skin is stable, mobile and tough enough to withstand the wear and tear of active life An elastic bandage has an advantage over an elastic stocking in that it can be put on at the correct tension not too tightly or too loosely but its appearance is not acceptable to many women for it makes grooves and bulges on the leg Again, some patients are unable to apply an effective pressure bandage.

The St. Thomas's Hospital (London) Method.—In the St. Thomas s Hospital clinic the treatment of venous ulcers and eczema has been reduced to a simple routine, which can easily be taught to nurses, students and

masseuses, who in turn can teach the patients This routine is fully illustrated in Figure 303, and a study of these pictures is all that is necessary

It is essential to emphasise a few points, however :—

1. The only two local applications used are olive oil (or arachis oil, its substitute) and cremor zinci (zinc oxide in castor oil) The olive oil is used

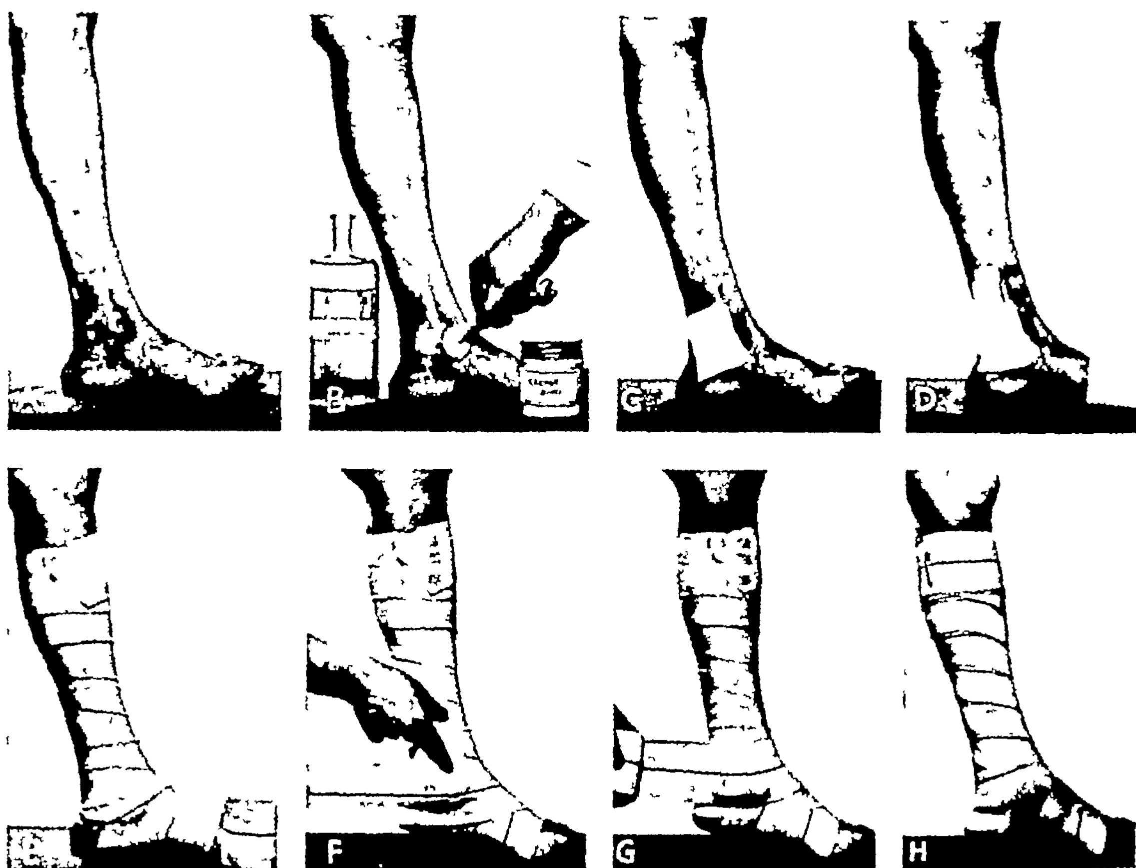


FIG 303

The St Thomas's-Bisgaard Bandaging Technique

A The leg with a typical venous ulcer B Cremor Zinci is applied to the ulcer itself, arachis oil is smeared on the surrounding skin C A piece of gauze is then laid over the area D, A felt pad, cut from a piece of white felt (on the right of the picture) is laid over the gauze so as to cover and overlap the ulcer, and extend up to the region of the ankle perforating veins E This felt is bandaged into position with a light crêpe bandage (the heavy webbing pressure bandage is seen to the right of the picture) F, G, H, show the steps in the application of the webbing bandage Note the extreme care taken to apply pressure by turns of the bandage *below* the internal malleolus, also note that the bandage must go up to just below the knee and is fixed by a *pin*. (Tapes allow the bandage to loosen and slip down quickly)

to bathe away flakes of discharge and scabs which accumulate from day to day, and to clean the ulcer The zinc cream is used as a dressing to the open surface of the ulcer itself, as shown (Fig 303)

These two applications are chosen because they never cause local skin reactions Almost every other local application gives an appreciable proportion of skin reactions In fact, most of the so-called varicose eczemas seen at our clinic are really drug-induced eczemas produced by a well-meaning

and hard pressed doctor who has in desperation tried one local application after another Once again we would reiterate a warning against the local application of penicillin preparations, or sulphonamide or flavine preparations. Severe sensitivity reactions to penicillin are among the commonest seen



FIG 304

The effect of the elastic pressure bandaging technique

A. A typical post thrombotic venous ulcer Note the eczema around the ulcer itself and the ankle flare of dilated venules below and the slight oedema of the ankle. B After two months pad and bandage. Note the area of the pressure pad is outlined on the skin. The ridges of the firm pressure bandage which has just been taken off are seen also the ankle oedema is completely controlled.

If local surface sepsis in the ulcer is a problem when first seen this can be rapidly brought under control by local application of a piece of gauze soaked in 1/1000 streptomycin solution The gauze is covered with a piece of oiled silk and worn under the pressure bandage, and is renewed night and morning. *Three to four days* of this application is enough to clear up sepsis when the local zinc cream dressing is reinstated. (*Streptomycin or Aureomycin must not be applied for more than four days as otherwise it may start a sensitivity reaction The danger is much less than with penicillin*)

2. The firm elastic webbing bandage used is capable of considerable pressure. Many women with sensitive skins find that it is too " fierce " to be

applied directly to the skin, and so it is better to apply it over an ordinary crêpe bandage as shown The tension should be greatest round the ankle The application of the bandage to cover and compress the whole of the area "*below and behind*" the malleoli is of vital importance, and the cutting and shaping of the felt pad to aid this by "filling in" the hollow behind the malleoli is essential in the early stages

3. This bandage is worn during the day only At night the patient is instructed to sleep with the foot of the bed raised 6 - 9 inches, and a crêpe bandage only The ulcer is dressed and the crêpe and webbing re-applied first thing in the morning The success of this method depends considerably on the co-operation of a patient, and meticulous teaching instruction in the exact method of putting on the bandage

Most ulcers heal on this routine, and the patient is then considered for elective surgery (Chaps VIII and XVII) or for continuous supportive therapy

For continuous support many patients prefer to carry on with their webbing elastic bandages and a felt pad This is certainly desirable in the larger post-thrombotic ulcers, but many of the smaller ulcers will remain healed with a firm elastic stocking A small felt or foam pad may be worn with advantage over the ulcer site, under the elastic stocking, to give it further support and protection

Crêpe bandages.—Plain bandages are used for compression after operation for varicose veins, when an ulcer or eczema is healed and after the injection of varicose veins where there is painful or oedematous chemical phlebitis They are invaluable for the ambulatory treatment of superficial thrombophlebitis They are psychologically helpful and, being removable, they allow bathing and unwrapping at night, which freedom is not permissible with the adhesive-pressure dressings *They are not strong enough to give enough pressure to heal venous ulcers round the ankle* A porous extensible bandage is valuable to cover a medicated bandage when acute eczema is present as its open mesh allows evaporation and thus coolness

Elastic stockings.—Well fitting elastic stockings are most helpful They are worn after an ulcer is healed, after operation for gross varicose veins, after deep thrombophlebitis (phlegmasia alba dolens) and extensive superficial thrombophlebitis of the legs They are a valuable support to aching heavy limbs due to incompetent deep veins or gross varicose veins with oedema pending operation They are less trouble and more pleasing to the eye than an elastic bandage Men wear them up to the knees but most women prefer them of stocking length so that they can be hitched up to a suspender belt. They are uncomfortably warm in hot weather and some patients are sensitive to the rubber in them

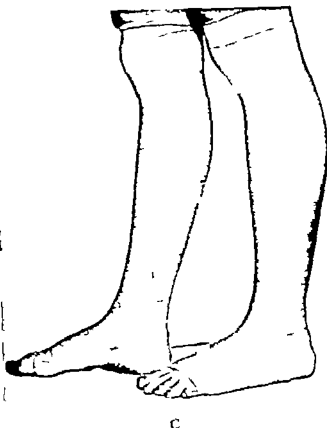
There are various weights, the thicker ones are necessary to give real support after healing of an ulcer and in circumstances where knocks are likely.

A

B

FIG. 305

Some examples of the defects in the fitting of elastic stockings. A. This is a bad fitting. The big gap over the heel means that there is no pressure just below the malleoli, where it is needed most. The stocking stops short of the root of the toes—oedema will develop in the skin between the end of the stocking and the root of the toes thus is a useless stocking. B A slightly better stocking, it comes down to the root of the toes and the heel gap is less, but there are ridges over the instep this will make it somewhat un comfortable. C. The "Suprema" knitted lastex yarn and nylon stocking. This fulfils the requi sites for a good elastic stocking. It has an elastic heel which fits snugly and gives elastic pressure where required. It is free of ridges, and goes down to the root of the toes.



C

e g. at work and travelling The thinner are suitable for social occasions and summer wear, but they do not give really effective pressure or protection It is important when ordering an elastic stocking to specify "stout," "medium" or "light" weight

They should cover the leg, including the heel from the root of the toes They are made to fit the limb as measured in the early morning before swelling appears with the erect position They have two assets, *viz* they compress the leg and thereby prevent or limit swelling, and they buffer it against the daily trauma which is scarcely noticed by those with healthy legs, but which, in those with venous disorders, often lead to eczema or ulceration In patients with the erythrocyanoid tendency they prevent or lessen cooling in winter and limit the tendency to swell in summer

INSTRUCTIONS TO PATIENTS WITH "OCCLUSIVE-PRESSURE" BANDAGED LEGS

The following printed instructions are given to each patient with an ulcerated leg which is treated by the occlusive pressure bandage technique They have been drafted with a view to making the rationale and details of the method clear to even those patients of meagre intelligence

"THE CARE OF LEGS BANDAGED FOR ULCERATION.

Your bandage is an application designed to correct the disordered condition in your legs which has caused the ulcer It is not just another dressing for your ulcer

Please study the following , it will help you to recover and then to keep well

(a) Care of the bandage

A painful bandage—Although at first the bandage may seem tight, it will soon become easier If it presses too much in one place, get someone to snick it for you with scissors or a pen-knife over the painful part If your toes become numb, blue, swollen or if you are unable to move them, please return for the bandage to be examined On no account take your bandage off, or its benefits will be lost The constant pressure on the leg by the bandage is essential for healing

Discharge—The ulcer may discharge and soak through the bandage , there is no need to worry, wipe it away with a soapy sponge, then cover it with cotton-wool and a bandage and change the pad when necessary

Sitting—When you sit if possible, raise the foot a little higher than the seat

Bathing—When you bath, try to keep the bandage dry, although a brief wetting will do no harm After bathing, dry the bandage with a soft warm towel not in front of the fire

In bed—The edges of the bandage may curl by rubbing on the bedclothes , wearing a stocking prevents this If your ulcer becomes painful when you lie down, try raising the foot of the bed , if this does not help, try raising the head of the bed

Renewal of the bandage—If the bandage becomes loose, its benefit is lost and you must return for a new one It is effective only when it is compressing the leg firmly At first, especially if there is much swelling the bandage may become loose in a few days Later, a well-applied bandage may last four to six weeks (As a rule, the less often the bandage is changed the better)

Cleanliness—Try to keep the bandage clean , a little soiling is unavoidable but guard against gross dirt

(b) Care of healed legs

Swelling and pressure—"If you don't allow your legs to swell, they won't swell (Oldham, 1953) Swelling leads to pain, eczema and ulceration It is easier to heal an ulcer than it is to keep it healed, so protect your legs by an elastic stocking or bandage Don't

scratch them when they itch, bandage them firmly instead. If you always protect your legs, as by a tight bandage, or elastic stockings, you will be able to do largely as others do without some support your troubles will probably return. This cover is needed, particularly in the winter and summer

(c) **General habits.**

Diet.—Unless you are a vigorous manual worker avoid salt, fats and fried food it will help to keep your weight down You can eat lean meat, chicken, fish, cheese (plain) eggs, fresh vegetables, fruit, boiled and baked potatoes (don't add butter)

Exercise.—Active daily exercise, such as walking or cycling, is essential. Standing as you work, or sitting with the legs down for long periods, *e.g* at the cinema, should be avoided You may sit and work or kneel and work but stand as little as possible If you must stand, remember to "mark time" every few minutes. Try to do your ordinary work so extra rest is required.

Footwear.—Wear robust laced-up shoes from early morning until going to bed, never slippers or high heels.

Recreation.—Recreation is necessary for everyone, so try to take up some activity *e.g* walking, cycling, dancing, golf bowls (indoor and outdoor) snooker badminton, tennis (table or lawn) Seek something you like and can do until you are at least seventy Sitting is not recreation

(d) **Periodic inspections.**—If you are asked to visit your doctor or hospital again do so in this way early signs of trouble may be found and treated. Legs "go wrong," especially in prolonged cold weather or by injury A periodic check will keep you safe from serious recurrence. Don't treat a recurrence of an ulcer yourself seek an appointment with your doctor at once.

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CHAPTER XVII

THE OPERATIVE TREATMENT OF VENOUS ULCERS AND THE POST-THROMBOTIC SYNDROME

IT has been known since the time of Richard Wiseman and before, that adequate pressure bandaging of the leg would heal venous ulcers Wiseman (1686), however, remarks "Thus (*i e* by the use of the laced stocking) may the greatest swelling accompanying varicose ulcers be removed, and the ulcers palliated, if not cured for it is confessed that they return again for the most part upon the discontinuing the laced stocking" This is as true now as it was in the seventeenth century

In Chapter XVI details of the conservative method of treating ulcers and the post-thrombotic syndrome were given It depends on the efficient application of elastic pressure over the gaiter area by some technique of bandaging This external elastic compression counteracts the local high ambulatory venous pressure in the subcutaneous tissues, which is the basic cause of the disease In order to control the lesions permanently, the patient must resign himself to wearing this elastic support nearly continuously for the rest of his life Moreover, in a significant proportion of cases even efficient bandaging only just holds the ulcer controlled, and relapse occurs whenever vigilance is relaxed, or after slight trauma.

Thus, in general, people who are otherwise healthy and active prefer operation if this can be offered with a fair chance of success It has been our experience that the age group 50 - 60 is a critical one in this respect. People over the age of sixty seldom wish for operative treatment if efficient conservative treatment by bandaging is satisfactory Those under fifty are usually keen to have operative treatment if possible Between fifty and sixty, it is very much a question of the patient's temperament and how chronic the lesion has become

There is another factor of prime importance in the operative treatment of ulcers This is that the chances of complete success from operation are much greater if it is undertaken early in the slow development of the disease *Ideally, surgical treatment should be preventative That is, operation should be advised as soon as the ulcer precursor signs discussed in Chapter XIV* (p 350) *appear, before actual ulceration has taken place* The venous dilatation throughout the gaiter area steadily progresses during the course of time After this has gone on for many years, and fat necrosis and infection have welded the superficial tissues into a solid fibrous plaque, the cutting off of the original source of venous hypertension (*i e.* a perforating vein with or without the long or short saphenous vein) may not cure this lesion It will only ameliorate it and will make it easier to control by pressure bandaging

The time for surgical treatment is when an ulcer first appears or threatens to appear

The principles of surgical treatment of venous ulcers.—This resolves itself into two problems —

1 The treatment of the ulcer itself
2. The eradication of the incompetent veins causing the ulcer

As was discussed in Chapter XIV in a large proportion of ulcers the main culprit is one or more incompetent ankle perforating veins The long or the short saphenous veins may also add their quota of incompetence, and may sometimes be the main and sole cause of ulcers (true varicose ulcers) However well over three-quarters of all ulcers in the St Thomas s series (whether associated with saphenous incompetence or not) had an incompetent ankle perforating vein near them which was one of the main factors causing the ulcer

The surgical cure of the ulcer therefore often involves an operation in the immediate vicinity of the ulcer itself and so the technique of these operations is closely bound up with adequate pre-operative measures to control infection in the ulcer and either heal it or bring it into a healing phase

General plan for surgical treatment of ulcers and induration of the leg. —The actual operation is only one part of the surgical programme In dealing with these lesions the pre-operative preparation and post-operative treatment are all important. The programme of surgical treatment is divided into four parts —

1 The diagnosis and assessment of which groups of veins are incompetent (*i.e* great saphenous small saphenous or ankle perforators—or all !)
2 The pre-operative treatment of the ulcer or lesion of the lower leg.
3 The operation
4 The post-operative management.

1 DIAGNOSIS

Many of the failures of surgery are simply due to a faulty diagnosis as to which groups of veins is defective, and therefore a failure to operate on these

2. PRE-OPERATIVE TREATMENT

As an incision near the ulcer and through indurated poor skin is often the essential part in the surgical treatment of these conditions it is very important to get this skin as near normal as possible before operating on it

The essential pre-operative treatment is (1) a period of efficient elastic compression with the patient ambulatory and at work or (2) *if necessary* a period of complete rest in bed with the foot of the bed raised These measures will bring about rapid healing or " near healing " of most ulcers

Of the two methods, the first is the more practical and useful and is just as good as the second in most cases, and entails less time off work and in hospital

3. THE OPERATION

Broadly speaking, ulcerated legs fall into two groups from the point of view of operative treatment. *Group 1* in which the ulcer is fairly localised, in which induration is not excessive, and in which the subcutaneous tissues just above and around the ulcer are fairly normal, except that they may contain a bog of dilated veins (Figs 257, and 307B) *Group 2* in which *induration* of a large part of the gaiter area is a prominent feature, and the subcutaneous tissues are replaced by a plaque of fibrous tissue which is welded to the deep fascia Over this indurated area there may be a large shallow ulcer of considerable area (Fig. 306)

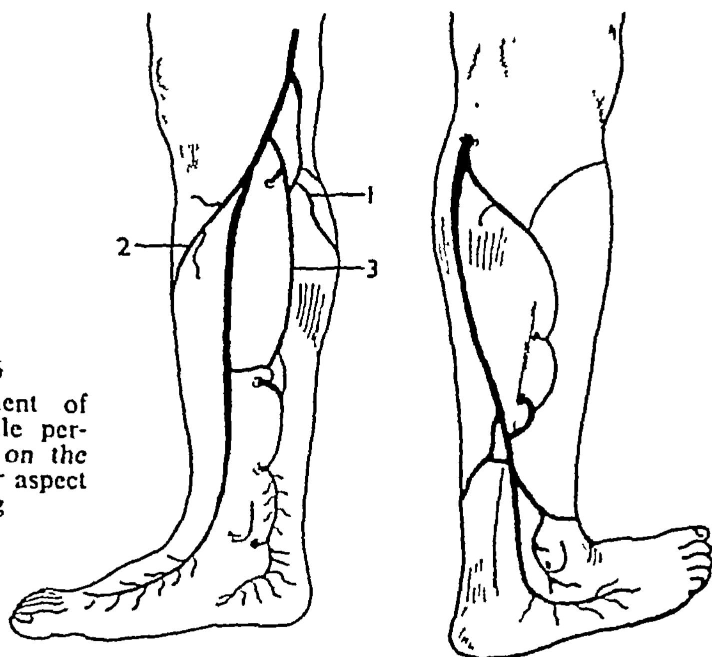


FIG 306
The arrangement of the direct ankle perforating veins on the inner and outer aspect of the leg

Group 1 is usually fairly easily and quickly controlled by one of the treatments mentioned, and pre-operative preparation may be complete in a few weeks

Group 2 is usually more of a problem, but pressure bandaging, or rest with the feet above heart level, will always produce steady healing even in these It may be a slow process, and it may be necessary to admit the patient to hospital and cover the ulcer by skin grafts One to three months or more with firm elastic support is then necessary to *consolidate* this new skin The leg is then ready for the exploration of the ankle perforators (Fig 313)

Principle.—The essential part of the operative treatment is the exposure and ligation of the incompetent veins

The following are the main groups of veins which have to be considered in the surgical treatment of a venous ulcer —

1 THE GREAT SAPHENOUS SYSTEM —This system need only be considered as a definite or contributory cause of venous ulceration in the lower leg if it is quite obviously enlarged and incompetent. Unless a cough impulse can be felt along the course of the veins, it is unlikely that incompetence of this vein is the main cause of the venous ulcer Venous ulcers due to incompetence of this system are usually associated with gross dilatation and incompetence which has been present for many years—and usually there is a boggy mass of large veins to be felt near or beneath the ulcer

The only adequate way of eradicating this source of venous incompetence is by high saphenous ligation and stripping (as described in Chapter VIII)

2. THE SMALL SAPHENOUS SYSTEM —Incompetence of this vein is more common than is generally supposed There is no easy test for its incompetence (like the cough impulse) and, as it lies deep to the deep fascia in the upper third of the calf its incompetence can often only be suspected by very careful palpation along the course of the vein when its enlargement can be detected Often when the back of the leg is inspected in a good light the enlarged vein can be seen (Fig. 263A) Its association with enlargement and incompetence of the lateral ankle perforating vein is common. In a fat leg its incompetence may be entirely overlooked until on exploring the region of the ankle perforating veins a large vein is found leading up to and connecting with an enlarged small saphenous vein (Fig. 263C)

When it is incompetent, it should be stripped from above and behind the external malleolus to the popliteal fossa (Chap VIII p 224)

3 THE DIRECT ANKLE PERFORATING VEINS —The anatomy of the direct ankle perforators will be found in Chapter III (p 55) Most ulcers and lesions in the gaiter area are mainly due to incompetence in the valve of one or more of these veins The ones which have to be considered are the upper and middle *internal* ankle perforators and the *external* ankle perforator (Fig. 306) *Thus the essential surgical treatment of the majority of ulcers involves the exploration of the internal or external ankle perforating veins or both* (marked in Fig. 306)

LIGATION OF ANKLE PERFORATING VEINS

They can be approached by an operation through the subcutaneous tissues the perforators being ligated as they penetrate the holes in the deep fascia the *extrafascial* operation They can also be ligated beneath the deep fascia—the *subfascial* operation.

If the subcutaneous tissues are reasonably normal (this means *early cases* and those cases classified as group 1 on page 426) the extrafascial approach is preferable if there is extensive induration of the gaiter area (group 2 as Fig. 293 advanced post-thrombotic ulcers) the subfascial approach is

preferred, because in these the subcutaneous tissue plane is scarred and obliterated and has poor vitality

In the extra-fascial approach an accurate incision over the line of penetration of the perforating veins is necessary Too much lateral dissection in the subcutaneous plane away from the incision, particularly in indurated



FIG 307
The skin incision for extra-fascial ligation of the ankle perforating veins. A Straight incision Note that the anterior line indicates the posterior border of the tibia B With excision of a small residual ulcer

or ill prepared legs, may lead to skin necrosis in the incision The main advantage of this approach is that it allows *a fairly complete removal of all the enlarged tortuous veins* IN *the subcutaneous tissues about the ulcer*. The removal of these, when present, is nearly as important as tying the perfor- vein which which they arise

In contrast, wide dissection laterally can be carried out in the plane without risk of skin necrosis, hence its suitability for the indur

These two operations will now be described in detail

Extrafascial operation (Fig 3) —The pre-operative skin preparat whole leg and foot is carried out with spirit and cetavlon It is import.

use iodine or flavine on these cases as a certain number react to these agents by an extensive eczema The patient lies on his back with the legs apart and externally rotated The operator sits at the foot of the table A slight Trendelenburg tilt to bring the feet *just* above heart level will effectively diminish bleeding

The incision is a straight one, which starts nearly half way up the leg, one finger s breadth behind posterior margin of the tibia, and is carried straight down to a point an inch above and behind the internal malleolus (Fig 307) It is carried straight down to the deep fascia If there is an ulcer or doubtful area of skin in the line of this incision this is excised en route (Fig 307B)

Any large veins in the subcutaneous tissues are dissected out and followed up and down they lead the operator to one or other of the perforating veins Usually either the upper or the middle perforator is found to be enlarged. The enlarged and incompetent one (or both) is then ligated at the site of its penetration into the foramina in the deep fascia and the plexus of subcutaneous veins is removed. Often a small artery is seen emerging through the same foramen *Any large veins which go off from the area around towards the back of the ankle to join the small saphenous system or lateral ankle perforator must be carefully followed particulaly if no satisfactory incompetent perforator has been found on the inside of the ankle* These may lead one to a clinically unsuspected incompetent small saphenous vein and/or incompetent lateral perforating vein These are dealt with through separate incisions (This has been our experience in an increasing number of cases)

The whole dissection is carried out *behind* the line of the great saphenous vein in this region which should not necessarily be seen *All ligaturing is done with fine catgut* Unabsorbable sutures should *never* be buried in this region. After haemostasis has been secured the skin is drawn gently together with fine silkworm gut or nylon sutures All tension must be avoided

If the case has gross incompetence of the great saphenous vein as well after the perforators have been dissected out the great saphenous vein is sought anterior to the line of emergence of the perforators It is divided and the vein stripper is passed to the groin Thus this same incision can be used for the lower part of the long saphenous stripping operation.

If an ulcer has been excised during the course of the operation (Fig. 310E and G) the area is covered with tullegras. It has been our practice to wait for four or five days for early granulations to appear before placing a split skin graft at a second operation.

If either the lateral ankle perforator is suspected to be at fault clinically or if no incompetent *internal* ankle perforator is found then the lateral per forator must be explored through a separate incision The patient is turned over and a short vertical incision is made over the position of this perforator (Fig. 312H) If both explorations (lateral and medial) are negative, the final vein to remember is the small saphenous vein This vein may present



FIG 308

The extra-fascial operation For three years Mr G T had complained of pain, swelling, eczema and irritation over the lower and inner third of the right leg There were no varicose veins of the great or small saphenous system Ascending venography showed the popliteal and femoral veins to be patent and normal (B) In the lower leg under the eczematous area, a localised mass of varices could be seen and felt (A) At operation they were found to be arising from a large incompetent internal ankle perforating vein, shown in the accompanying photographs (D and E)







FIG. 308—*contd.*

Three years later the wound was soundly healed and there was no sign of recurrence. No support was worn. A. Shows eczema, swelling and varices about the inner ankle. B Venogram showing normal femoral and popliteal vein with valves. C. Venogram showing localised subcutaneous varices about the ankle D Shows area of inner ankle perforating veins exposed at operation. *Note* large upper perforator (arrow) E. Closer view of large perforator F "Leg recovered."

a number of anomalies (*see* Chap III, pp 37 and 39), but one of the most interesting and important is that in which it passes into the soleus in the midline half-way down the leg—constituting a large mid-calf perforating vein (Fig 28, p 39). When this is incompetent it can be responsible for severe ulceration We have met this anomaly several times, in each case causing severe trouble (Wright, 1954).

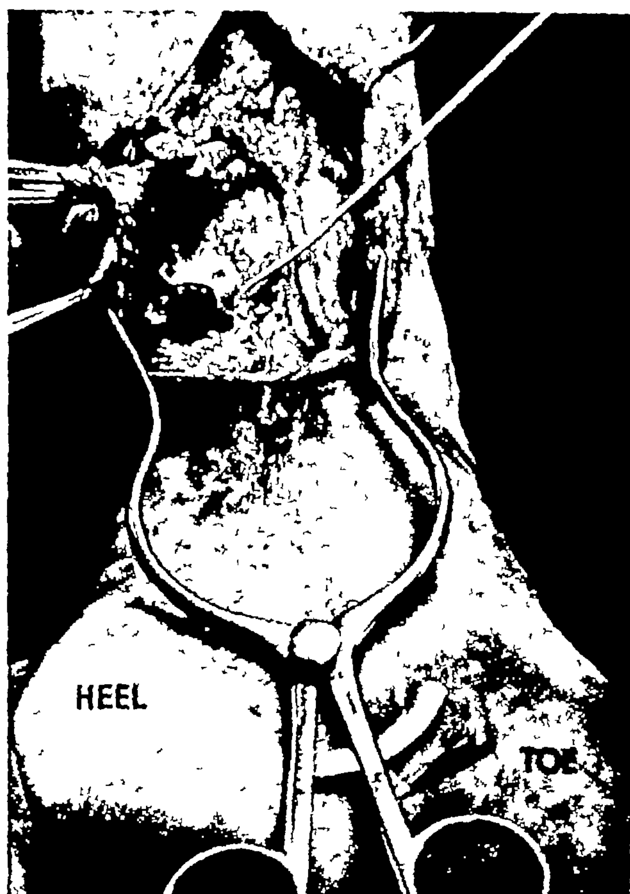


FIG 309
The extra-fascial operation An operative photograph showing the site of the middle perforating vein which is incompetent in this case Note its position is behind the great saphenous vein, which can be seen running anteriorly It is connected with the mass of thrombosed varices which are being held out of the way by artery forceps on the left of the plate

Points of importance in the extra-fascial ligation.—(*a*) In this operation the deep fascia surrounding the lower third of the soleus is left intact This firm investing layer is an integral part of an efficient calf pump in this region, and its opening is unnecessary in this operation

(*b*) A *straight* incision, going precisely to the line of penetration of the perforating veins, is important In this way all excessive undercutting of

skin is avoided Undercutting of skin in this region inevitably leads to destruction of the small perforating arteries and thus increases the possibility of skin necrosis. This point has also been emphasised in the section on anatomy Linton (1953) also insists on the necessity of using a straight incision for this procedure.

(c) In ligating the incompetent perforating veins it is important to ligate them flush up against their foramen in the deep fascia for the same reason that it is important to do it in the high saphenous ligation In fact the operation described here is the counterpart of this but performed in the lower third of the leg

(d) The bleed-back test (Turner Warwick)

There is one sure way of telling whether a perforating vein is incompetent by the fact that, on cutting across it, smart back bleeding from the deep veins occurs. If a *normal* competent perforating vein is cut, no bleeding occurs from the cut end which goes into the posterior tibial veins as its valve effectively prevents the egress of blood. If a probe is gently pushed into its lumen the valve is held aside and smart bleeding occurs until the probe is withdrawn. This has been observed at operation many times by us On the other hand, an enlarged and incompetent perforating vein bleeds back smartly as soon as it is cut.

Sub-fascial operation (Fig. 310) —This operation has been developed by Linton of Boston (1953) and is the operation of choice in the advanced case with woody induration Again it must be emphasised that adequate pre operative preparation with firm bandaging—to reduce oedema and either heal the ulcer or get it into a healing phase—is absolutely necessary

The incision is an inch posterior and parallel to the posterior border of the tibia It is carried straight down to the muscles through the deep fascia It is important that it should be a *long* incision It should start more than half way up the leg and should stop just short of the internal malleolus as the lower part of the incision may give rise to delayed healing if carried too far into the post-malleolar groove The perforating veins are sought by lifting the whole of the anterior flap (consisting of skin subcutaneous tissue and deep fascia) by retractors and burrowing gently forwards in the sub-fascial plane until the internal perforating veins are seen passing into the muscles. The anterior flap of deep fascia is raised until the posterior border of the tibia is seen, as occasionally a perforating vein is close to the bone. They are divided and ligated with catgut. By burrowing under the posterior flap in the same way to the postero-lateral aspect of the leg the small saphenous vein can be inspected (and stripped if necessary) and the anomalous mid calf" perforator sought for and the lateral perforator can be reached if the incision is long enough (It is just outside the tendo-Achillis three to seven inches above the tip of the external malleolus.)

Linton then recommends that a sheet of the deep fascia should be excised

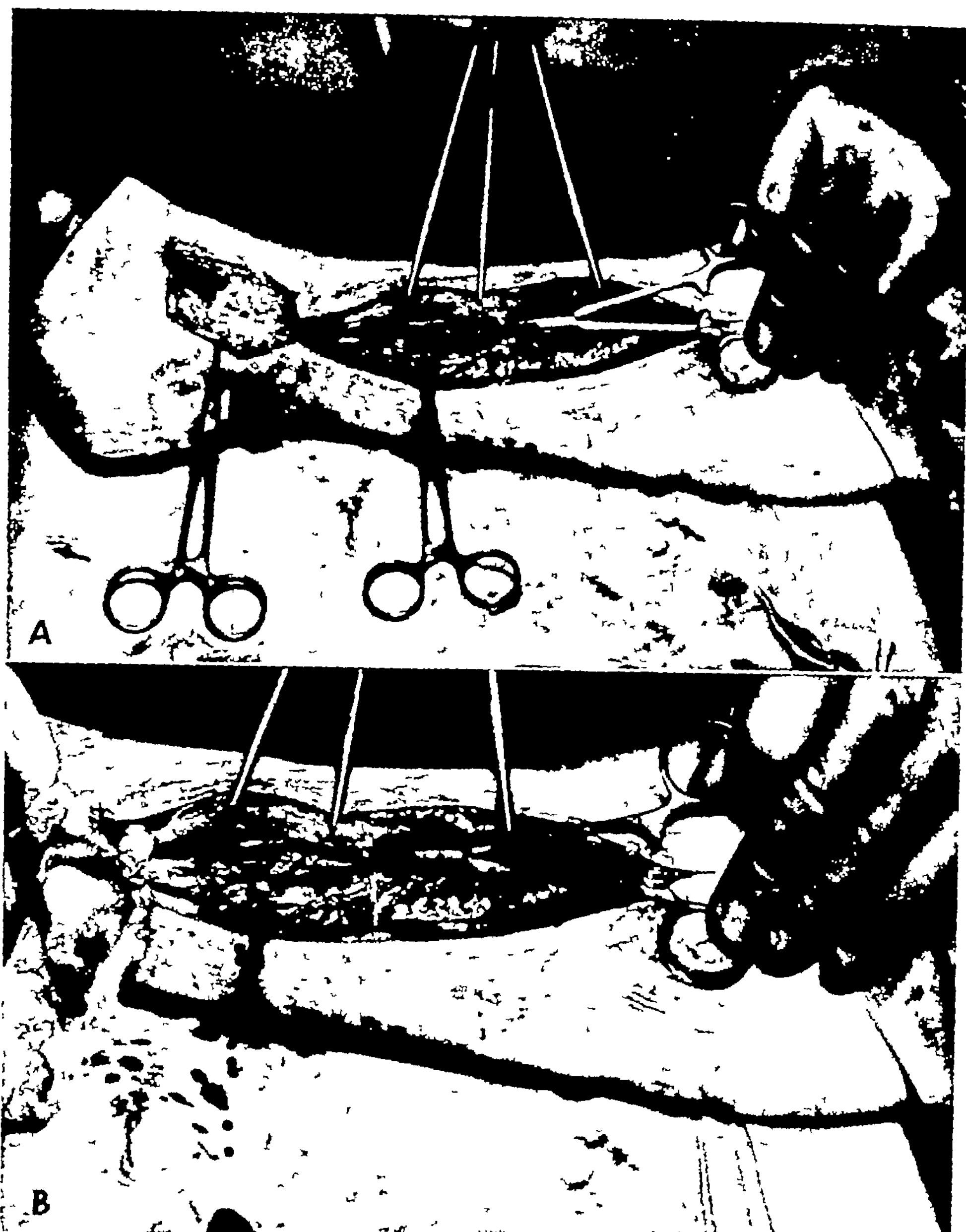


FIG 310

The sub-fascial operation

The pre-operative photograph and venogram of this patient's leg will be found in Chapter XIV (Figs 259C and D) A The ulcer has been excised, a straight incision has been made down to the muscles The anterior flap of deep fascia (dissected up from the muscles) is shown held up by three artery forceps The upper internal perforating vein is shown emerging from the medial border of soleus with an artery forceps thrust behind it The middle perforating vein is about two inches distal to it with an artery forceps on it B *The bleed-back sign* The artery forceps have been removed from the middle perforator and smart bleeding back from the deep veins has occurred (a gush, with the drops of blood falling on to the towel) C The upper internal perforator has now been divided between artery forceps and the middle perforator has been secured again, ready for tying with fine catgut D The deep fascial layer is *loosely* approximated with fine catgut E The skin is closed with silk-worm gut sutures and tulle gras is placed over the bare area from which the ulcer was excised (this will be grafted in 5 - 6 days' time) F Firm bandaging of leg from toes to knee at the end of the operation, with strong crêpe bandage Note, foot of the table is up G The leg two months after the operation to show the sound healing The patient is at work with a firm stocking only at this stage

This has not been our practice however We have either gently approximated the fascia with a few interrupted fine catgut stitches or frequently left it open



FIG. 310—*contd.*
See legend on p 434

and then closed the skin. In closing the skin it is important that a large number of small sutures close to the skin edge should be used If large bites are taken with the sutures there is an added risk of causing necrosis of the skin edges Fine braided wire is suitable for this purpose. It can be left in for ten to fifteen days without any reaction. Turner Warwick (1931) Sherman (1949) and Wright (1954) have also described similar operations



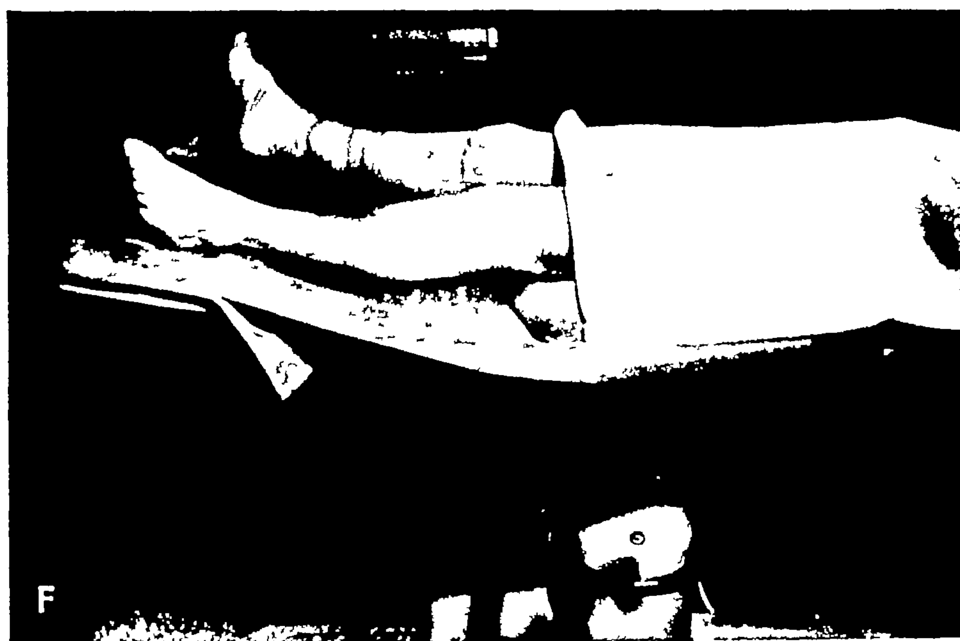




FIG 310—*contd*
See legend on p 434

Complications of operation.—The most upsetting complication of this operation is necrosis of the skin edges of the incision Our cases of serious necrosis of the skin were early in the series before the importance of the pre-operative preparation of the leg, and of undercutting the skin too widely had been appreciated. One case took four months to heal her necrotic skin incision After this salutary lesson a good deal more attention was paid to (1) the choice of case (2) the pre-operative preparation of the leg (3) the operative technique and (4) the meticulous after-care Since that time there has been no case of serious skin necrosis Minor skin necrosis confined to a part of the edges of the incision occurs in less than one-fifth of the cases beyond the fact that it delays healing and requires a regime of firm elastic support for a little longer than normal it in no way affects the result. The incidence of skin necrosis rapidly decreases with the care and experience of the operator Very few other complications have been observed. There have been a few cases of sepsis (as opposed to skin necrosis) which have responded to drainage and antibiotics There have been a few cases of post-operative calf thrombosis, which settled on a regime of elevation and support followed by exercise.

No case of pulmonary embolism has occurred in the St. Thomas s series reported in Chapter XIV We believe that this has been due to the post operative measures to combat venous stasis in the legs (post-operative elevation, exercises and early ambulation with firm support)

4 POST-OPERATIVE MANAGEMENT

The most important point in the post-operative management is to relieve the area from all venous stress' in the immediate post-operative period The following points are important.

(*a*) A firm crêpe bandage is applied from toes to knees including the ankle, immediately on completion of the operation.

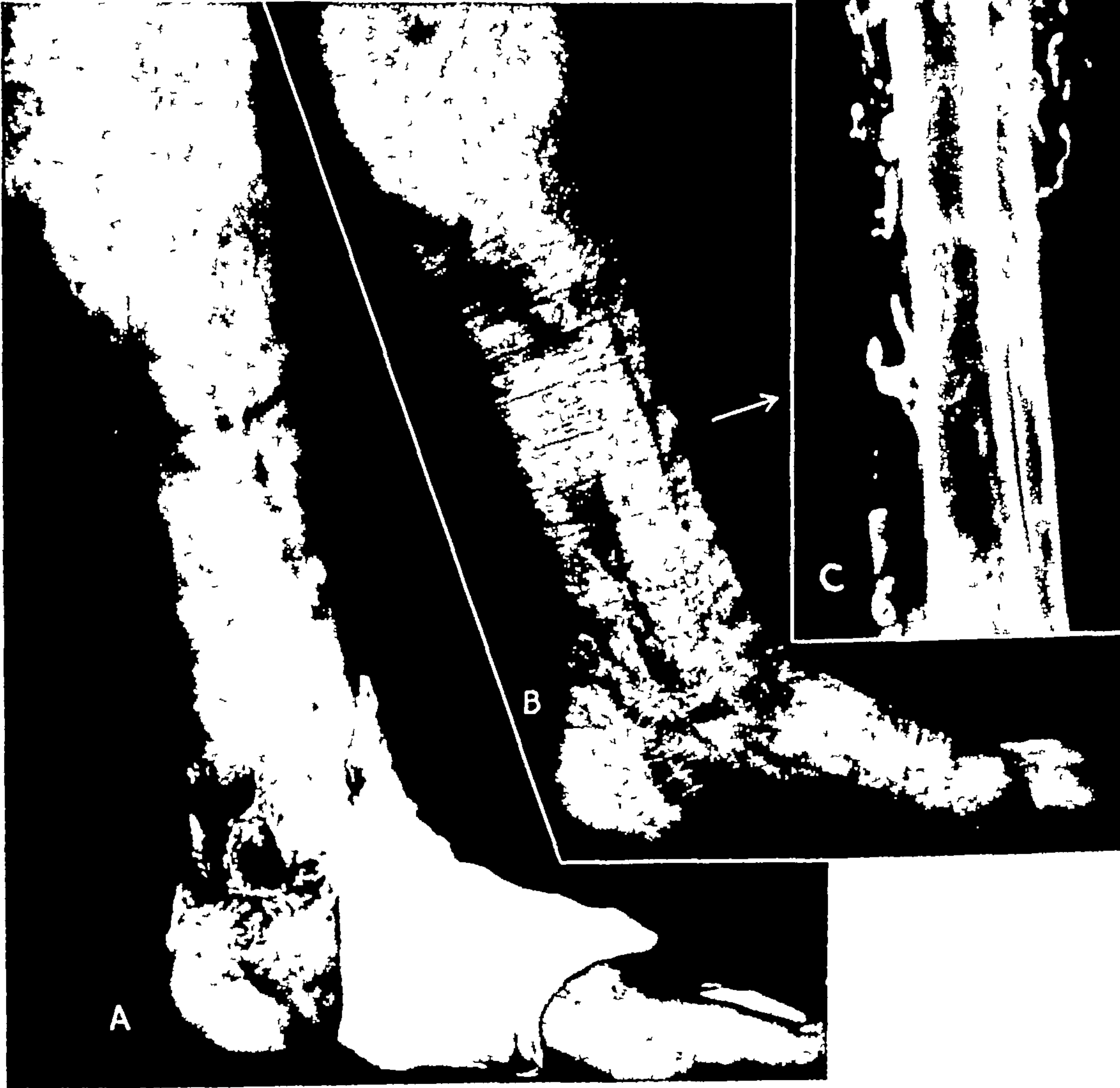
(*b*) The foot of the bed must be raised or put on blocks for the first forty-eight hours to lessen the venous congestion of the operative site (and it is desirable to have the foot of the bed raised during the whole of the patient s stay in hospital)

(*c*) Active leg and foot movements are instituted at once to prevent thrombosis

If there has been merely a straight incision, without ulcer excision the patient is allowed up on the third or fourth post-operative day with his leg well supported from toes to the knee by a strong elastic webbing bandage which fits snugly round the malleoli and operation site. Stitches are removed on the eighth to tenth day The patient may be discharged from the hospital on the fourth or fifth day but he must be instructed to wear his webbing bandage for three weeks to one month after the operation at least, until the whole operation area has " settled down " and feels comfortable

FIG 311

The cause and treatment of a recurrent varicose ulcer Mrs E H (aged 57) had had this varicose ulcer for fifteen years when first seen A high saphenous ligation and several operations which had controlled the varicose veins of her great saphenous system had failed to have any effect on the ulcer A venogram showed a large internal ankle perforating vein just above the site of the ulcer (indicated by the arrow) This was exposed and tied by the extra-fascial operation, and the ulcer excised and grafted in April 1952 When last seen in June 1955 (over three years after the operation) the ulcer was completely healed and she had worn no bandage or support of any kind for over two and a half years She had "forgotten" about her ulcer A Before operation B Six months after operation C Venogram (pre-operative)



If an ulcer has been excised and grafting has been done at a second operation the post-operative care is of some importance The patient should be in bed with feet well raised for about one week after the graft, then he is allowed up for increasing periods with full elastic support and a felt pad over the operation area We have found it possible to discharge such patients seven to ten days after the grafting, on full support but this must not be relaxed for six weeks or more when the graft should be well "bedded in." After this some lighter support, such as an elastic stocking, is worn for about three months when the decision as to whether or not to try the leg without any support can be made. In the less extensive cases all support can be gradually discarded from two to six months after the operation. In most patients who have had severe widespread ulceration with induration and a history of a white leg it is wise to warn the patient to be prepared to wear a good firm elastic stocking for all ordinary activities for life

RESULTS —A detailed analysis of 201 lower leg explorations in cases of ulcer will be found in Chapter XIV (p 357) assessing the frequency with which the various perforators were found at fault. But it is notorious that any operation purporting to ameliorate or cure ulceration of the leg must be judged in the light of a follow-up of up to five years at least. Moreover the results may be influenced by a number of ancillary factors such as (1) the effective elastic support which may be given at the same time (2) the period of bed rest in hospital (which in itself tends to heal venous ulcers) (3) change of occupation (from a job on the feet to one more sedentary)

In the light of these known facts, the operations on the perforating veins have given by far the most promising results yet seen in our clinics. The patient shown in Figure 311 is typical It is three and a half years since her operation and for the last three years she has been back at full housework with no supporting bandages of any sort. Most of the patients of clinical groups 1 with so-called varicose ulcers (Chap XIV p 346) and 3 with "ankle blow out syndrome have either discarded all support or are occasional wearers of elastic stockings (that is to say they wear elastic stockings at housework or at work but discard them for outings) However most of the patients of clinical group 2 (Chap XIV p 346) with post thrombotic limbs with incompetent perforators and complete destruction and recanalisation of the deep system, have continued to wear elastic stockings Even in these patients it has been striking how the operation has helped to maintain sound healing of the ulcer and has made the leg feel much easier and useful

The place of skin grafting in venous ulcers.—Venous ulcers, large and small, once the surface has been cleaned, take split skin grafts extremely well. However the follow up results of grafts alone (where perforating veins or varicose veins have not been dealt with) are extremely poor As the basic venous cause of the condition has not been dealt with the grafts either re ulcerate or " crumble away in a few months unless they are firmly supported



FIG 312

The steps in the management of a severe post-thrombotic syndrome with venous ulceration A B C & D Shows the patient as she presented She was a young woman of 38, and the legs

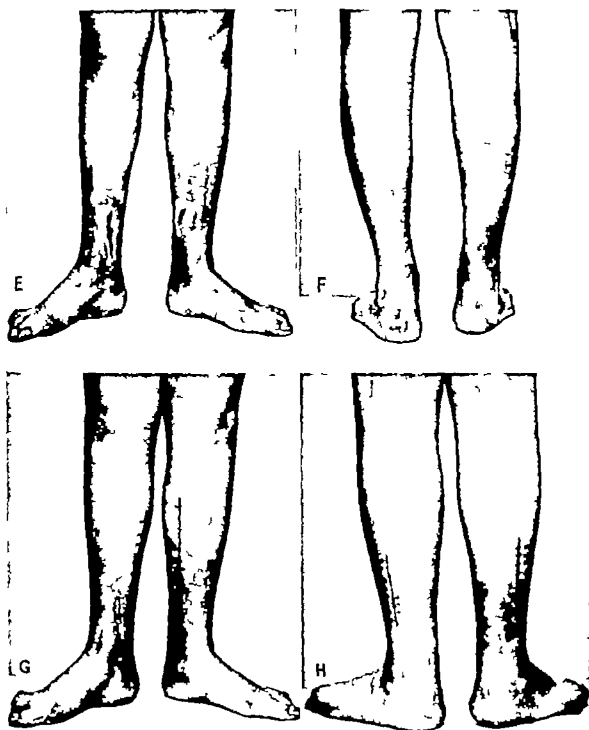


FIG. 312—*contd*

had reached this state five years after a post-partum white leg. They were oedematous, very painful, she could not get her right heel to the ground and she was completely incapacitated. E. & F After a period of rest in elevation, and compression bandaging, this amount of healing was achieved. However they continually threatened to break down with conservative treatment. G & H. A sub-fascial ligation of the ankle perforating veins (internal and external) was performed, and this photograph shows the result six months after the operation. The patient wears elastic stockings only now and does a full day's housework

Most venous ulcers heal so rapidly and well on the pressure bandage routine described in Chapter XVI that we now hardly ever have to skin graft the average case There are two exceptions to this statement: (1) small, chronic, very fibrous ulcers These are sometimes excised completely during the course of the operation for ligating the perforating veins, and covered with a split skin graft a few days later. Figure 311 shows an example of this (2) In the vast, shallow surface ulcers, which occur on the indurated champagne bottle type of leg These ulcers will heal surely and well once infection is controlled, and either the routine pressure bandage ambulatory treatment is applied *or* the patient is put to bed with the feet up (Fig 312) However, by virtue of the area of surface ulceration involved, this may take a long time This can be cut short by covering the area with split skin (Thiersch) grafts cut from the thigh with a Humby knife, and cut up into small squares (the so-called "postage stamp" grafts). The clean ulcer is covered with these "postage stamps" of skin and they usually "take" and coalesce extremely well They need continuous firm pressure bandaging in the post-operative period, and especially when the patient gets up They are not firmly bedded in until after about two months' supportive pressure bandaging

These legs will usually re-ulcerate unless continuous compression bandage support is worn or the venous pathology is dealt with surgically. This grafting procedure is occasionally necessary to get skin cover before doing the operation for sub-fascial ligation of perforating veins (Fig 313).

Thus skin grafting is of little permanent benefit unless the basic cause of the ulcer (incompetent perforating veins and/or long and short saphenous vein) are dealt with at the same time, or shortly afterwards.

Deep vein ligation and the post-thrombotic syndrome.—As we have seen in Chapter XIV, after an acute femoral thrombosis (white leg), complete recanalisation of all the deep veins occurs in the majority of cases Recanalisation and organisation of the thrombus destroys the valves, leaving a valveless deep channel running right down to the calf. However, this valveless deep channel may consist of several relatively small slits (rather like Figure 253) or it may be a large dilated single valveless channel (like Figure 254) The latter is obviously more capable of transmitting retrograde venous pressure than the multiple channel recanalisation type (which is the commoner in our experience). Recanalisation and organisation takes between one and two years to become complete, and it is about that time (one to two years *after* the acute thrombosis) that the symptoms of the post-thrombotic syndrome may begin to make their first appearance These symptoms are (1) ulceration and induration, (2) chronic oedema, (3) a certain amount of deep-seated aching in the lower leg

For many years it was believed that it was this valve destruction in the main deep veins (femoral and popliteal, etc) that was primarily responsible







FIG. 313

To illustrate the steps in the treatment of a large venous ulcer. A. The original lesion. Note the swollen ankle and the widespread surface ulceration. B. *Stage* 1 in the surgical treatment. After a short period of rest in elevation to reduce oedema and control infection the ulcer was covered with split skin grafts (postage stamp grafts). C. *Stage* 2 of surgical treatment. After four weeks full support and compression with webbing elastic bandages the patient was re-admitted to hospital for a sub-fascial ligation of the ankle perforating veins, and a complete stripping of her incompetent great saphenous vein. Note that the ankle incision for the sub-fascial ligation operation has gone right through the grafted ulcer but has healed satisfactorily. Also note the difference in the general contour of the ankle as compared with A.

for the onset of the ulceration and induration syndrome of the ankle (Bauer, 1948). This reasoning which led to large-scale attempts to cure or ameliorate the syndrome by ligating these valveless deep veins (either the popliteal or the femoral). Now, as we have shown in Chapter XIV, destruction of valves in the main femoral and popliteal veins is *not* a prerequisite for the development of induration and ulceration of the ankle, and in fact we have found that many of the so-called post-thrombotic ulcers have normal valves in the popliteal and femoral veins Højensgaard and Sturup (1949, 1952) came to the same conclusion from a study of venous pressures in the leg

However, though destruction of these main deep valves may not be directly contributory to development of induration and ulceration, it certainly contributes to the amount of oedema and general discomfort and aching in the leg in these patients Those patients in whom oedema and an aching calf towards the end of the day are major complaints, usually have a *large* valveless deep channel (commoner) or a completely and permanently obliterated deep vein (rare)

Ligature of the deep recanalised vein for relief of the post-thrombotic syndrome was first suggested and carried out by Homans However, it was not until Bauer published his glowing reports of the results in a large number of cases of ligating the popliteal vein, that this procedure really caught the surgeon's imagination and was fairly widely taken up Disappointment in the results of the operation quickly followed

Deep vein ligation and ulceration—It is highly probable that any good effects on the ulcer which may accrue are the result of the ancillary treatment that is carried out at the same time, *i e* bed rest and tight elastic bandaging of the ankle Reports recently published from a number of different sources (Linton 1953, Moore 1953, Goligher 1953, Cockett 1953 and 1955, Boyd *et al* 1954) make it clear that *deep venous ligation in itself has little effect on the course of ulceration and induration of the lower leg This is only to be expected from a consideration of the pathology, because the basic cause of this part of the post-thrombotic syndrome is purely local, the destruction of the valves in the ankle perforating veins*

Deep vein ligation and swelling of the leg—The effect of the deep vein ligature on the amount of swelling in the limb is negligible in our experience If a *truly recanalised* incompetent deep vein is tied, it has no effect on the swelling and does not cause oedema However, if a *normal* femoral or popliteal vein (*i e* one with valves) is tied, usually the swelling is increased and the patient has more oedema than before the operation; this is a mistake which has been made in the past

Deep vein ligation and leg pain—The effect of ligation of a large incompetent main channel on the deep aching pain in the leg and calf, however, is to ameliorate it and make the limb easier Many writers (Bauer 1948, Linton 1953, Moore 1953, Cockett 1954) have remarked upon this and in fact it appears to be the only definite beneficial effect of a deep vein ligature

In performing this operation for pain it is essential to be sure that it is being done for the right sort of pain Most patients with recent ulceration have some degree of pain and aching in the erect position and the pain is in the lower third of the leg at and around the ulcer The true generalised aching of the leg and calf muscles as the day wears on—due to deep vein incompetence—is a *much rarer* complaint It has been our experience that many of our patients whom we thought had this typical deep aching pain lost it after the ligature of the ankle perforating veins and healing of the ulcer

Thus to sum up the effects of ligation of an incompetent deep vein (either femoral *or* popliteal) are as follows —

On ulceration and induration	Nil
On swelling	Nil
On pain and aching	Some effect in certain cases

In general therefore we think that ligation of recanalised deep veins has little place in the surgery of the post-thrombotic syndrome

Indications for deep vein ligation—This should only be done (1) when it has been shown that a period of supportive bandaging which heals the ulcer does not abolish or ease the calf pain (2) when eradication of incompetent veins of either the long or short saphenous systems or ankle perforators, if present, has been done without relief (3) when it has been shown by a reliable venographic technique that the deep vein is in fact patent, valveless and pathological. In such circumstances ligation of the deep vein (popliteal or femoral) will bring relief from the pain and a grateful patient (especially if he or she has work which entails being on the feet all day) They are relatively rare but they do occur and the operation should only be advised by surgeons who have special experience in vascular surgery

Ligation of the incompetent femoral or popliteal vein.—Pathological femoral or popliteal veins can be recognised at operation They differ from normal veins in the following respects —

1 They are more adherent to the femoral sheath and the artery and it is sometimes a tedious business dissecting them out.

2. The wall of the vein may consist of a very thin walled portion giving place to a longitudinal white fibrous strand, clearly seen through the vein wall. This appearance is typical of a recanalised vein, quite different from the homogeneous bluish white appearance of the normal femoral or popliteal vein. The fibrous thickening and irregularity within the recanalised vein can sometimes be appreciated by palpation between finger and thumb

3 On exposure the presence of functioning valves in the vein can be tested by retrograde saline injections—as described in Chapter VI (p 156)

The main points in their exposure are as follows —

POPLITEAL VEIN —(1) Always make a transverse or S incision in the skin of the popliteal fossa. Longitudinal incisions are very liable to weak scars, keloid formation and contracture (2) The external popliteal nerve is superficial

lying just under the deep fascia on the lateral aspect of the popliteal fossa The tibial nerve is on a deeper plane between the short saphenous and the popliteal veins (3) The vein is superficial to the artery, but closely bound to it in the vascular sheath (4) The vein is ligated on the upper part of the popliteal space

FEMORAL VEIN —The best site for its ligation is distal to the entry of the profunda vein in the upper third of Hunter's canal. (1) A longitudinal incision over the vein in the lower part of the femoral triangle is made. (2) The femoral vein lies *deep* to the artery, and the latter may have to be mobilised to expose the vein. (3) There may be several good sized venae comites about the artery here—they must not be mistaken for the main femoral vein A wide exposure avoids this

The place of sympathectomy.—Linton (1948) said "Lumbar sympathectomy has been used in our clinic in a number of cases, but unless it is combined with some other form of treatment it has not cured the ulceration." Later experience in the Massachusetts General Hospital vascular clinic (Linton, 1953) confirmed this view, and gave grounds for supposing that sympathectomy alone, if anything, worsens venous ulcers, and certain of these cases developed a chronic eczematous condition between the toes This has also been seen in our follow-up of cases treated by sympathectomy (Cockett 1953), that is, we are in agreement that, in the ordinary case of venous ulcer, sympathectomy confers no benefit

As the effect of lumbar sympathectomy is to increase the arterial blood flow into the superficial tissues of the leg and ankle, it is obvious that this will only aggravate the congestion of these tissues, which are already suffering from an impaired venous return It therefore only further increases the burden on the already incompetent venous system

There are, however, two groups of cases which lumbar sympathectomy may help: (1) Those in which obliterative arterial disease is present, as well as post-thrombotic ulceration, and (2) where venous ulceration occurs in women with erythrocyanosis frigida, a lumbar sympathectomy performed about the same time as the local operation on the perforating veins will hasten and consolidate healing

With these two rare exceptions lumbar sympathectomy is *contra-indicated* in venous ulceration

CONCLUSIONS

1 The post-thrombotic syndrome consists of pain, swelling, induration, eczema and ulceration about the ankle (One, two or all of these features may be present in one leg)

2 The destructive feature of the post-thrombotic syndrome is *the incompetent ankle communicating veins.* Superficial varicose veins and valveless deep veins contribute to a lesser and varied extent

3 Before operation the swelling induration and ulceration are overcome by continued pressure bandaging (Chap XVI) supplemented if necessary by rest and elevation of the foot above the heart level

4 *Skin grafting* is occasionally required followed by *pressure support* until the graft is consolidated.

5 *The key* of the treatment is the *complete location and division of the faulty ankle communicating veins* Varicose veins of the long or short saphenous systems are ligated and stripped as necessary

6 When in spite of adequate operation on these leg pain continues, *the ligation of a large valveless femoral vein* may give some relief

7 *Lumbar sympathectomy* —Has little contribution to make in the treatment of the post thrombotic syndrome with the rare exceptions of the erythrocyanoid and ischaemic limb

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